HORTICULTURAL AND ECONOMIC PLANTS OF THE NILGIRIS

Edited by **S. Krishnamurthi**
B. Sc. (Agri.), M. S. (Calif.), Ph. D. (Mich. State)
PROFESSOR AND HEAD, DEPARTMENT OF AGRICULTURE ANNAMALAI UNIVERSITY; FORMER CURATOR, GOVERNMENT BOTANIC GARDENS, OOTACAMUND AND PARKS, NILGIRIS AND ASSISTANT FRUIT SPECIALIST IN CHARGE OF HILL FRUIT STATIONS, NILGIRIS

1953

PRINTED AT
THE COIMBATORE CO-OPERATIVE
PRINTING WORKS, LIMITED
COIMBATORE, S. INDIA.

Rs. 6/12

Dedicated to

THE GOVERNMENT BOTANIC GARDENS
OOTACAMUND, NILGIRIS

for over hundred years of useful work
on horticultural and economic plants

PREFACE

by HON'BLE SRI M. BHAKTAVATSALAM
Minister for Agriculture, Government of Madras

This is indeed an interesting and instructive collection of articles on the valuable wealth of the Nilgiris. Several experts in the fields have made their contribution. The Nilgiri District being the most highly developed hill station, particularly in the matter of plantation and horticultural crops, this timely publication, I have no doubt, will be welcomed in the country. The brief but informative article on the important problem of soil-erosion adds value to this publication. The article on "Useful Trees for the Nilgiris" should be helpful to those interested in the regeneration of our forests.

I offer my congratulations to the learned and enthusiastic editor of this compilation and to the Centenary Committee of the Government Botanic Gardens on their bringing out this useful publication.

M. BHAKTAVATSALAM

MADRAS
22nd November 1953

FOREWORD

by DR. C. P. RAMASWAMI AIYAR
Vice-Chancellor, Annamalai University

Mr. H. C. M. McLaughlin, the present Collector of the Nilgiri District, has been taking a lively interest in the development of the Botanic Gardens, Ootacamund, which is, or rather can be easily converted into a model for all Asia. He has co-operated in the task of conducting and implementing propaganda to minimise, if not eliminate, the insensate de-forestation that has almost ruined one of the fairest spots of the world. In this work, he has been greatly helped by Dr. S. Krishnamurthi who has been the Curator of the Gardens and is now Professor and Head of the Department of Agriculture in the Annamalai University.

A very useful and instructive Centennial Souvenir of the Gardens was issued in 1950 in connection with the Centenary Celebrations, and Dr. Krishnamurthi has now edited and brought out an interesting survey and description of the horticultural and economic plants of the Nilgiris which he rightly claims to be the premier hill resort of South India.

An account of the tea, coffee and cinchona industries in the Nilgiris is furnished by acknowledged experts and there is a useful article devoted to the cultivation of wattle for tan bark. Several species of the eucalyptus plant which were introduced into that district about a century ago have been described in great detail. These trees are among the largest in the world and being superior in rapid growth to most others are specially suited for fuel production. They have also been instrumental in the starting of a widespread cottage industry devoted to the extraction of oil.

There may be difference of opinion as to the value and necessity of cutting down trees for the purpose of planting potato, but there is no doubt that at present the potato is a great economic stand-by and much research has been devoted in the Potato Research Station to the improvement of its tuber.

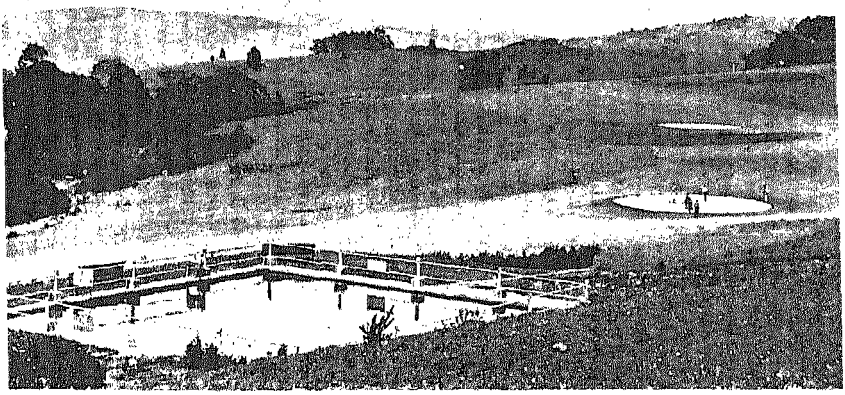
A very comprehensive account of the vegetables and the fruits of the Nilgiri hills is also made available to us, but it is a pity that fruit-growing on a scientific and really economic scale has been sadly neglected. One of the recent developments on the hills has been the cultivation of pyrethrum, a most valuable insecticide which was originally confined to Japan and the Far East, but is now widely cultivated as part of the anti-malarial control operations. The Nilgiri plateau is now bare of any real forests, but it is hoped that a renewed interest on the part of the government and the public will stimulate a well-designed scheme of afforestation, without which the water and power resources of the district, and indeed of South India, will be gravely jeopardised.

The public must be grateful to Dr. Krishnamurthi for his labour of love in having brought together in a short compass, all the available information on a subject of great interest and value.

C. P. Ramaswami Aiyar

Annamalainagar
November 1953

THE DOWNS, OOTACAMUND



The Ootacamund Golf Course in the foreground

Toda huts in the foreground

INTRODUCTION

by MR. H. C. M. McLAUGHLIN
Collector, The Nilgiris, and
President, Ootacamund Botanic
Gardens Centenary Committee

At the outset, I would like to say a few words about the Nilgiris.

> "Just a little bit of heaven,
> Dropped from out the sky one day."

The Irishman who wrote this song about his country evidently had not visited the Nilgiris of South India. I do not mean to deny his assertions of all he says about beautiful Ireland; but one has only to visit the Nilgiris to realise that there is no spot in the world more beautiful than these "*Blue Mountains*" (*Nila* means 'blue'). The name is said to have been derived from the violet blossoms of the masses of "*Strobilanthes*" which periodically carpet wide stretches of the grass downs of the plateau.

The Nilgiris consist of a great plateau about 35 miles long and 20 miles broad. It has an average height of about 6,500 feet, but there is rarely a square mile of level ground in the plateau. Its surface consists of a sea of rounded green hills, rising now and again into more prominent heights and ranges, which are covered with short grass sprinkled with bright flowers and often dotted with Rhododendron trees. These rounded hills are divided each from the other by streams or bogs, and nestling in their folds are beautiful little woods, the foliage of which yearly assumes a wide variety of tints from the brilliant rose colour of the young shoots of certain species in the spring to the deep green of the ripe autumn leaves. Dodabetta (big mountain) 8,640 feet high is the highest peak. This mountain rises east of Ootacamund.

What of our climate? It is here that we have the greatest advantage over any other holiday resort in the world; for of the many surprises and delights which greet the visitor, the most wonderful and engrossing is the equable

climate. The most eloquent testimony regarding the climate is borne out by the following statistics. The mean average temperature is between 56·9° and 62·3° F. At Ootacamund, the largest town on the plateau and the summer residence of His Excellency the Governor of Madras, the difference between the average minimum temperature of the warmest month in the year (April) and that of the coolest (January) is less than nine degrees; while the difference in the average maximum is less than seven degrees. This surely proves that the Nilgiri possesses one of the most temperate and equable climates on the face of the globe. The rainfall, owing to the influence of the hills on the monsoon currents, varies greatly at the several periods of the year in different localities. The annual average rainfall in Ootacamund is 48·35 inches.

I could fill a book about the game available and hunting stories of this paradise of shooting, — elephants, tigers, leopards, the Indian sloth bear, sambur (elk) spotted, four horned and mouse deer; antelope, bison, pig, the Nilgiri ibex and wild dog; besides hare, and the fast and sturdy hill jackal which is the quarry for the Ootacamund Hunt Club. In addition to the game animals, a few others deserve special mention — the Nilgiri langur or black monkey, the long-tailed Hanuman monkey and their more common cousin of the plains, and the striped necked, the ruddy and the brown mongoose. There are seven species of squirrel found up here including the shy flying squirrel, that inhabit the dense forests of the lower slopes and that can only be seen late in the evening, and that by a quick eye, as they glide from tree to tree. The porcupine that does so much destruction in our potato fields and proves an unpleasant antagonist to any hound of the Hunt Club, which may riot on the strong scent he carries. The game birds include two kinds of green pigeon, the Imperial pigeon, the Nilgiri wood pigeon, pea-fowl, jungle-fowl, spur-fowl, quail, snipe and wood cock. There is fishing to be had in our lakes and rivers that are especially stocked with trout by the Nilgiris Game Association.

Painted in the most beautiful scenery, endowed with the most temperate and equable climate, and stocked with the choice of game—*truly all this gives to Nilgiris the undisputed*

title of the Queen of Hills, and to Ootacamund, that of the Queen of Hill Stations.

In 1950, Dr. S. Krishnamurthi who was then the Curator of the Government Botanic Gardens suggested that we should celebrate the Centenary of the Government Botanic Gardens. The suggestion was immediately taken up and a three day exhibition was staged under the guidance of a special Centenary Committee composed of the Heads of the Government Departments of the District, the United Planters' Association of South India and leading residents of the district and organisations, and in co-operation with the Nilgiri Agri-Horticultural Society. The celebration was such a success, that the Committee decided that we should tell the rest of India and the world about the potentialities of this wonderful district. It is surprising how few people even in India know the true value of these hills. Tourists and residents of the country dismiss it as "just another Hill Station". Except for its tea and coffee plantations, business men are ignorant of its horticultural and economic possibilities. With the object of bringing these possibilities before the people of India and the world, Dr. S. Krishnamurthi has edited this interesting book.

Dr. S. Krishnamurthi has worked hard on this publication; and 'with malice to none' I can say that most of the credit goes to him. Our thanks are due to him and his colleagues for putting together all this interesting information. May it lead to a better understanding of not only this Queen of the Hills, but also of the possibilities that lie dormant within her. It now needs only the hand of the enterprising and the imaginative to induce her to shower her blessings upon New India.

H. C. M. McLaughlin

Ootacamund
November 1953

EDITOR'S INTRODUCTION

In the year 1948, the Government Botanic Gardens, Ootacamund, completed a hundred years of valuable work on horticultural and economic plants. It is with the establishment of these gardens in 1848 that horticultural work in the Madras State can be said to have commenced in a useful and systematic manner. Horticultural work of a high standard at Ootacamund, commencing with Mr. W. G. McIvor from the Royal Botanic Gardens, Kew, England in charge of these gardens, resulted in establishment of plant industries of great importance to the country as a whole and to the Madras State in particular. Cinchona, potato, a number of varieties of European (temperate) vegetables, a range of tropical and sub-tropical varieties of fruits and a number of medicinal plants, essential oil plants, spices and beverage crops now established in the Nilgiris are contributions from the staff of the Curator, Government Botanic Gardens, Ootacamund, whose horticultural activities were spread over the whole of the Nilgiri District. As a tribute to the services of this institution, lasting over a hundred years, its centenary was celebrated in May 1950 by a committee, when the editor happened to be the Curator of the Government Botanic Gardens, Ootacamund. Mr. H. C. M. McLaughlin, the Collector of Nilgiris was the President of this committee and the then Minister for Agriculture, Hon'ble Sri A. B. Shetty, highly interested in the Gardens, inaugurated the Centenary Celebrations. In connection with this, series of papers on the plant industries of the Nilgiris were read by specialists in the field under the presidentship of Sri R. M. Sundaram, I. C. S., a well-known administrator in South India, who was one of the ablest Directors of Agriculture which the Madras State had and who took great interest in the Government Botanic Gardens, Ootacamund and in the agri-horticultural activities of the Nilgiris. These

papers were considered very informative and educative. When in 1951, the editor joined Annamalai University as Professor and Head, Department of Agriculture, Mr. H. C. M. McLaughlin, President of the Ootacamund Botanic Gardens Centenary Committee called upon him because of his previous experience on the Nilgiris to compile and edit information on the horticultural and economic plants of the Nilgiris and thus assist in publishing a book on this subject. In the summer of 1952, the editor revisited the Nilgiris for this purpose, and to obtain the corroboration of other workers in the field. In the midst of the editor's own absorption in work connected with the starting of a new department of agriculture in the Annamalai University, he has attempted to do his best in the work which he undertook. Ornamental horticulture on the Nilgiris is itself a specialised branch, and it has not been possible to include this within the compass of this book, whose size had to be restricted for several reasons, and whose purpose was to cover plants mostly of economic utility.

The articles in this book have been planned, wherever feasible, to furnish a history of the plant industry under treatment from its introduction on the Nilgiris up to the present day, giving information on the methods of culture as practised in this hill district, problems of insect pests and diseases and their remedies, organisational handicaps, lines of research followed up-to-date and the future envisaged. This has been possible in the case of well established plants such as tea, coffee, potato, cinchona, and in the case of those plants where systematic work has been done as in pyrethrum and wattle, but this has not been possible in several other cases, because much systematic work has been lacking and informations available warrant merely a very brief account. This is quite true of several essential oil plants, medicinal plants, spices and condiments. Even with regard to several species of eucalyptus and numerous species of trees which have been established in the Government Botanic Gardens, Ootacamund, Sim's Park, Coonoor and elsewhere for a very long time, much attention has not been given to a systematic study of all these species and of their potentialities for economic and industrial exploitation. For the first time,

in this book, a brief account of these species has been presented. It is hoped that this book will serve, if nothing else, the purpose of impressing on those concerned the necessity for further more exhaustive work on the numerous species likely to be of economic utility on the Nilgiris. The book deals in one way or another with nearly 550 species of horticultural and economic plants. It is not exactly the administrative district of Nilgiris which has been covered, since certain adjacent parts which belong to the plateau had necessarily to be dealt with.

The plants of the Nilgiris treated in this book should not be considered as of local importance to this hill district alone. The plant industries of the Nilgiris play a role in the economy of the nation which is out of all proportion to the size of the district. The tea and coffee plantations established over a century and quarter ago dot all over the slopes of the Nilgiris producing crops and products of the best quality in the world, contributing in no small measure to the national wealth and foreign exchange. Apart from this, the pioneering role which the Nilgiri district has played in introduction, establishment and expansion of certain economic plants of importance to the country's well-being is worthy of national attention. It was the Nilgiris which introduced cinchona for the first time and became the source of its expansion in the rest of India and Ceylon and placed in the hands of these countries a key drug *quinine*, for controlling the scourge of malaria, which stands among the foremost national preblems. It was the Nilgiris which introduced for the first time more than hundred years ago the blue gum as both a cheap fuel and essential oil yielding tree, and for a long time it has been almost the only source for eucalyptus oil which has come to be known as *Nilgiri oil* and is used in almost every Indian household as a home medicine against chills, colds, and fevers. It was the Nilgiris which succeeded in 1942 in producing *ergot* on rye by artificial methods, containing the highest alkaloid content in the world (1·19 percent of ergotoxine), and also placed in the hands of the nation self-sufficiency of ergot, another essential drug which used to be imported from abroad and whose production was the exclusive monopoly of three or four countries in the world. It is the Nilgiri hills which bid fair

to make good the gap in the country's need for silk gut ligature from silk-worms reared on *mulberry* in the suitable climate of Coonoor. It is the Nilgiri hills which have shown possibility in the country of growing *pyrethrum*, one of the most important insecticidal plants, on a large scale and the Nilgiri pyrethrum has shown the highest average pyrethrin content in the world (2·08 percent). It is the Nilgiris which introduced *wattle* trees for the first time in 1840–43 and demonstrated particularly in recent years the profitability of growing large-scale plantations of wattle to meet the country's needs of wattle bark for its important tanning industries, since import from South Africa has been entirely stopped. The Nilgiri plateau in the whole of India was the first to establish orchards of *mangosteen* said to be about the most delicious fruit known and thus ranks among the few places in the world which have succeeded in establishing this difficult-to-grow exclusive fruit. Not only this, it is perhaps the only zone in India which can exhibit the range of sub-tropical and temperate fruits found in its fruit stations, including *avocado*, *durian*, *cherimoyer*, *persimmon*, *bilimbi*, *carambola*, *litchi*, *rambutan*, *star apple*, *rose apple*, *feijoa* and a host of others.

The Nilgiri district has been similarly important to the Madras State in which it is situated. It is almost the only source of *potato* to this state and its direct contribution to food production in this respect should not be minimised. It has also an export market in potato as far as Ceylon in the south, Bombay in the west and Calcutta in the north-east. The Nilgiri district is one of the few zones where growing of *wheat* has been in vogue in Madras State and with the lifting of the ban on wheat growing, a fairly large production of wheat would be possible in this district. The Madras State is one of the few states in India with a sizable silk industry, and one of the lines in increasing the size and quality of silk cocoons is by hybridization of the indigenous with foreign races from the temperate climates of China and Japan, which can only be maintained under climatic conditions which are found in Coonoor in the Nilgiris, which therefore maintains the Government Silk Farm for the purpose. One of the specialities of the Nilgiris is production

of temperate vegetables known as *English vegetables* of a fine quality, for utilization elsewhere in the state. Its potentiality in vegetable production is such that during the World War II, besides its usual trade in vegetables, the Nilgiri district exported 50 tons of vegetables per day to meet the military needs as far south as Ceylon. The Nilgiri district at present maintains a pure source of the Criollo variety of *cacao*, and considering that world supplies of cacao fall short of the demand, offers possibilities for its expansion.

Besides all this, the horticultural and economic plants of the Nilgiris are mainly exotic and have been introduced through the years from foreign countries and established under the environments of these hills; and therefore, they are something different from the types of plants usually found in the tropical plains of India, but at the same time they are important in one way or the other to the country as a whole. As such it is expected that information on these plants found in this book will be of some interest to the students of botany, horticulture, agriculture and forestry, and to the planters and farmers of the hills of India in general. It is also presumed that research workers working on economic plants in sub-tropical and temperate zones will find some information of common interest in this book.

One cannot write anything about the Nilgiris, much less about the cultivation of horticultural and economic plants without mentioning the seriousness of soil erosion on the Nilgiris. An article on soil erosion has therefore been included. The Pilot Soil Conservation Scheme, run by the Madras Department of Agriculture has shown some positive results, and latest data available indicate that bench-terraced plots in 1953 season have shown 60 percent increase of potato yields over non-protected plots. This indicates the necessity for pursuance of schemes of soil conservation to the benefit of the district and of the hydro-electric projects in the plains below the hills, which depend for water source on the rivers from the Nilgiri hills, which carry down at present dangerous quantities of silt.

For the benefit of those who are not very well acquainted with the Nilgiris, it may be stated that *The Nilgiri* means in English the *Blue Hill* or *Blue Mountain*. It consists of a

plateau about 35 miles long and 20 miles broad with an average height of about 6,500 feet lying at the junction of two chains of mountains, the Western and Eastern Ghats of South India, and most of it forms an administrative district by itself in the Madras State known as the Nilgiri District. This hill area has on its north the Mysore State which is itself a plateau about 4,000 feet lower, and on the other three sides lie parts of the Madras State, on the west being the Malabar Wynad, on the South the low lands of the Malabar proper and on the East the Coimbatore district which has come to be known as the Manchester of South India because of its highly efficient and extensive textile industry. The British came into this area in the first quarter of the 19th century and the salubrious and stimulating climate in the higher elevations impressed them so much that they energetically and quickly set up sanatoria and pleasure resorts at suitable places such as Ootacamund (about 7,500 feet elevation), Coonoor (about 6,000 feet elevation), Kotagiri (with similar elevation), and also established a British Military Cantonment at Wellington adjacent to Coonoor. They soon linked this hill district with the surrounding areas by first class permanent highways, some of them among the best in the country for motor cars and buses, these highways running ziz-zag and climbing ravines. They subsequently set up a rack railway and connected Ootacamund at the top of the hills to the railway terminus at Mettupalayam at the base of the hills, thus linking the very top of the Nilgiris to the main Southern Railway artery which runs through important towns and cities to Madras City and thus connecting Nilgiris to rest of India. The climate of particularly Ootacamund impressed the British Governors of Madras State to such an extent that it became the summer capital of Madras State, and the Government of Madras shifted every year for nearly six months from Madras City to Ootacamund. The fame of these hills as hill resort spread far and wide, and with rapid development, the Nilgiri hills came to be called the Queen of Hills in India and Ootacamund, the "Queen of Hill Stations". It is under these circumstances that the Nilgiri district came to be the most highly developed hill district in India, and no other hill

resort provides as many amenities for the visitors by way of communication, transport, climate, hotels, games, and sports; and no other hill district has seen such an intensive activity in growing of horticultural and economic plants. The attention of the readers is invited to the "Introduction" by Mr. H. C. M. McLaughlin who is the administrative head of the Nilgiri district, which gives an idea of the district as a whole.

It must be pointed out here that the economy of the Nilgiri district as far as plant industries are concerned has depended entirely on foreign plants, and the eventual success of these plants as commercial or economic plants has depended on the care which was bestowed on the initial stages of introduction of these plants and the methods which were evolved in propagation, multiplication and cultural practices. The debt the district owes to the labours of workers who devoted their time and knowledge for successful introductions must be remembered, and it is hoped that the present and future workers in the field will endeavour to give new plant introductions the same care and attention which the old ones received. It is earnestly hoped that the varying climatic conditions on the Nilgiris will be availed of even more intensively in the years to come in increasing the plant wealth of these hills. For some details of climatic conditions on the Nilgiris, the articles connected with potato and fruits, and "Introduction" by Mr. H. C. M. McLaughlin may be referred to.

The titles of the articles in the book as provided by the authors of the articles have been retained and the repetition of "Nilgiris" or the Nilgiri Hills" or "Nilgiri District" in the titles of articles has therefore been inevitable. It is possible that some plants have been dealt with by different authors in perhaps slighly different ways. The writers who are specialists have been permitted each one his views in the matter. The expressions "On Nilgiris" meaning "on the Nilgiri Hills" and "in Nilgiris" meaning "in the Nilgiri District" are both in vogue and have been permitted to be used.

Under peculiar conditions in India where English is a foreign language to atleast the workers in the printing presses, to produce a technical book without errors inspite of careful scrutiny is a difficult task. Added to this, the

editor had the handicap of lack of a suitable colleague who could spare the time for correcting the proofs thoroughly, and this work had to be done solely by the editor amidst extreme pressure of other duties. The students of botany are invited to refer to the index, for the accuracy of all the botanical names and families occuring in the text as it has been checked as well as possible. L. H. Bailey's *The Standard Cyclopedia of Horticulture (1950)* has been the main source of authority for botanical names, but in the case of plants not occuring in this book, Hooker and Jackson's *Index Kewensis*, J. S. Gamble's *Flora of the Presidency of Madras*, and Willis' *Dictionary of Flowering Plants and Ferns (1952)*, have been among other sources of reference. Over the long period of a century and a quarter of work in the Nilgiris on horticultural and economic plants, this is the first time that an integrated account of their performance has been attempted, and a first attempt may not always be a perfect attempt, but at any rate paves the way for better accomplishment in the future.

Dr. C. P. Ramaswami Aiyar, Vice-Chancellor of the Annamalai University has made his permanent home in the Nilgiris and few could equal him in his enthusiasm for developing the Nilgiri hills to the utmost possible extent, and his distinguished participation in the Centenary Celebrations of the Ootacamund Botanic Gardens made the public keenly aware of the problems of soil erosion, and of the future of plant industries on the Nilgiris. The Pykara Electric Project which supplies electricity to a large part of South India harnesses the Pykara falls on the Nilgiris and this pioneering project established when such schemes were in their infancy in South India owes its execution to Dr. C. P. Ramaswami Aiyar, when he was a member of the Madras Government. A foreword from him is therefore eminently fitting, and thanks are due to him for his kindness. The editor also acknowledge his thanks to the Hon'ble Sri M. Bhaktavatsalam, Minister for Agriculture for kindly furnishing the preface and for his kind words of encouragement. The editor is personally aware of his deep interest in the development of the Nilgiris in general and of the horticultural and economic plants in particular. The editor

is very much indebted in various ways connected with this publication to Mr. H. C. M. McLaughlin, Collector of the Nilgiris and President, Ootacamund Botanic Gardens Centenary Committee, and it must be frankly admitted that but for the facilities which he afforded and the consistent encouragement which he gave, this book would not have been completed. The editor's thanks are due to all the members of the Centennial Committee and to those who have corroborated with the editor in the completion of this book.

There are numerous others to whom the editor is grateful for their assistance, particularly to Mr. Geo. Farley, Secretary, the Nilgiri Agri-Horticultural Society and the Society itself, for all the kind co-operation in this project of publishing the book, to Sri C. R. Muthukrishnan, Superintendent, University Experimental Farm for assistance in the preparation of the index, and to Sri B. Narasimham, Horticultural Assistant, Agricultural College, Bapatla for kindly going through contents of the book prior to publication, and to Sri L. M. Nanjappa Row of Coonoor who facilitated the editor's trips to remote parts of the Nilgiris.

The following sources of photographs in the book are acknowledged with thanks: The India Coffee Board for the photograph on coffee, The Sunbeam Studio, Ootacamund for the photograph on potatoes, and Sri Venkatesh of Sri Aurobindo Ashram, Pondicherry, for the photographs of sections of the Government Botanic Gardens, Ootacamund and Sim's Park, Coonoor.

Above all, the editor is extremely thankful to the Coimbatore Co-operative Printing Works, Ltd., particularly its Secretary, Sri A. Subramaniam, for the kind co-operation in the printing of the book.

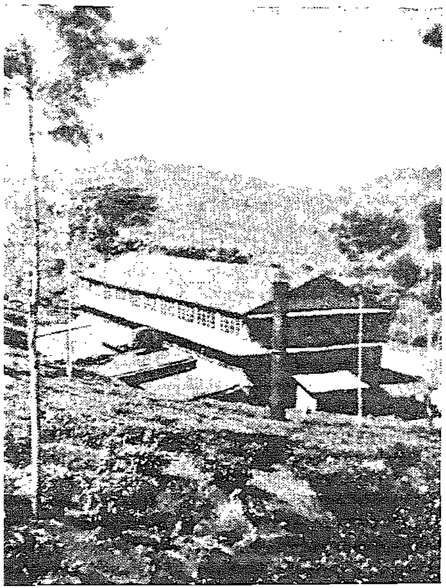
In the preparation of information on a variety of plants such as found in this book, the editor and his corroborators would no doubt have consulted a number of references, too numerous to mention, and they may kindly be forgiven for not having been able to acknowledge them individually.

S. KRISHNAMURTHI

ANNAMALAINAGAR
November 1953

CONTENTS

LIST OF ILLUSTRATIONS


A tea factory on the Nilgiris.


A tea plantation on the Nilgiris with women picking leaves

1. TEA ON THE NILGIRIS

by PETER DE JONG, B. A. (HONS.), Oxon.
Chief Scientific Officer, United Planters' Association of South India

THE EARLY DAYS

Tea as a commercial commodity, is the product of the tea plant, *Camellia sinensis*, which is cultivated in many tropical and sub-tropical regions throughout the world. Our earliest knowledge of tea, as a beverage, is derived from China where tea drinking dates back some 2000 – 3000 years; but there exist records of its prior use as a medicine. Authorities consider that the tea plant spread from its primary centre in the hills of Northern China along the old Thai trade routes to the secondary centre in Assam, but precise information regarding the origin of the tea jungles of Assam is still lacking.

The cultivation of tea in Japan dates back to the 12th century. It forms a major industry in India, Pakistan, Ceylon and Indonesia. In recent years, it has been grown extensively in Kenya, Uganda, Tanganyika and Nyasaland. Large areas are in cultivation in the Caucasus, while in a less degree it has been developed in various parts of Asia, Africa, South America and most recently Australia.

Unfortunately we do not possess a great deal of information regarding the introduction of tea into South India. The basis of the plantation industry here, as we know it today, was coffee; and competent authorities set its introduction at the end of the seventeenth century. Tea does not make its appearance until more than one hundred years have passed.

In 1832, Dr. Christie, a surgeon on the Madras establishment, was placed on special duty to conduct meteorological and geological investigation in Southern India. Within a short time, he applied for a grant of land in the Nilgiris for experimentation with the culture of tea, coffee

and mulberry and at the same time for the exclusive privilege of making ice for sale in the Presidency. He died in November of the same year and of his tea plants, three were given to the commandant of Ootacamund, Colonel Crewe, who put them down in the garden of Crewe Hall and the rest distributed to various parts of the hills for trial.

As long ago as 1788, the authorities at Kew had urged that the planting of tea should be undertaken in India, and in 1834, unaware that the plant was to be found wild in Assam, Lord William Bentinck the then Viceroy of India, sent a commission to China to fetch seed and expert tea makers to India. The result was a distribution of plants to many parts of South India for experiment. Those on the Nilgiris were planted chiefly at the experimental farm at Ketti, cared for by Col. Crewe and M. Perrottet, a French botanist, and were reported in 1839 to be growing luxuriantly, but it was another fifteen years before attempts were made to grow tea on the Nilgiris on a commercial scale.

AREA AND IMPORTANCE

Statistics also are not readily available for the 19th century and tend to be conflicting, but it can be said that by 1897 there were upwards of 18,000 acres planted with tea in South India, of which some 3000 to 4000 acres were on the Nilgiris. This latter figure excludes some 2000 acres established in the district now called the Nilgiris Wynaad. At about this time, the industry began to expand, and by 1920 the acreage rose upto 82,000 acres in South India with 7000 on the Nilgiris; by 1930 to 1,44,000 acres and 13,000 respectively; by 1940 to 1,63,000 and 19,000 respectively with the process continued upto-date to 1,65,000 and 22,000 acres respectively. The number of estates on the Nilgiris approaches 200.

India and Pakistan conjointly form the largest tea producing area in the world and since partition, which has affected the importance of jute in India for export, tea has become this country's principal export commodity and dollar earner. In addition to this export trade, there is an ever increasing home market.

In 1949, India as a whole produced some 550 million pounds of tea, of which 99 millions were grown in South India. Turning our attention from South India to the Nilgiris, we find that in 1949 this district produced nearly 14 million pounds of tea from the 22,000 acres under the plant, a district average of nearly 650 pounds per acre, which compares very favourably with a general South Indian average of some 600 pounds per acre, calculated on the foregoing figures.

CULTIVATION

For commercial purposes, tea is grown as a bush, by checking its natural habit of growth as a tree (30 or 40 feet high) by regulated pruning. Tea is manufactured from the young fresh leaves of the plant, known as 'flush' and a recurrence of 'flushing', that is the production of new leaf, is ensured through periodical pruning. The size of the bush is dependent upon two factors; firstly, its species or variety, some varieties naturally not exceeding a height of two or three feet in bush form and secondly, on the height of the pruning and tipping levels which are designed to produce a plucking table accessible to the hands of the pluckers throughout the 'pruning cycle' which means the interval between prunings.

In India, tea is grown from near sea level to about 8000 feet elevation and in the Nilgiris we have probably some of the highest grown tea on record. It is a hardy ever-green plant whose natural habitat is a hot, moist climate, flourishing best where there is plenty of sun and rain. It yields its biggest harvests in the hot-house atmosphere of the tropical or sub-tropical plains, but the best quality teas are obtained from the slower and consequently smaller yielding growths of the higher elevation.

The tea plant starts its life in a nursery, either as a seedling or as a cutting. The latter method of vegetative propagation produces plants of known qualities and hence has been in recent years advocated for tea. After a period upto two years in the nursery, the young plants are put out in the field and when they are established, their future shape

is determined by the initial pruning. After this, the bush is pruned at regular intervals throughout its life to maintain its shape and to encourage its functional activity of flush producer. There are usually some 3000 – 3500 bushes per acre in a tea field.

Interval between pruning varies to a very great extent, and generally increases with higher elevation. In the Nilgiris the cycles vary usually between four and six years.

While pruning is an operation calling for high skill and care, proper cultivation of tea calls for even greater attention. Tea estates must always be well and systematically cultivated for conservation of soil, maintenance of soil-moisture and tilth, weed control, proper correction of nutrient deficiencies by organic and inorganic manures, and above all the maintenance of general health and vigour of the bush. A good cover of tea is one of the best ways of ensuring maximum soil fertility.

The three major plant nutrients required for the growth of the tea plant are nitrogen, potash and phosphoric acid, and manuring by the addition of these elements in some form or other is carried out to a greater or less extent in the various districts according to local conditions.

In terms of yield, response is greatest to nitrogen, the effect of this element being to promote leaf production, but both potash and phosphates play a major part in the metabolism of the bush, creating conditions for the most efficient utilisation of the nitrogen. Nitrogen is supplied not only as the main component of inorganic fertiliser mixtures but through the presence of the leguminous and other trees and shrubs grown among the tea as shade and as a source of green manure and mulch. The nutrients are derived from the end products of the breakdown processes of the shade tree loppings and tea prunings as well as from the nitrogen-fixing micro-organisms living in association with the leguminous plants.

In South India, harvesting the crop, '*plucking*' as it is called, takes place throughout the year, the intervals between pluckings depending upon the rate of growth of the new flush, which in turn is governed by environmental conditions.

During rush periods, which in the Nilgiris occur usually between March and May and to a lesser degree in August and September, rounds of plucking are made at intervals of seven days or less, while under adverse conditions of climate, the intervals may extend to fourteen days.

Plucking is a highly skilled operation usually carried out by the female members of the labour force and consists of removing by hand all the harvestable young flush above the plucking level. In the majority of cases, plucking is restricted to the terminal bud and the two most recently expanded leaves, popularly called "*two leaves and a bud*" while fine plucking is anything less than this, and coarse plucking indicates the inclusion of any extra leaf or leaves.

The maintenance of a well regulated stand of shade trees is an important feature in the cultivation of tea. Not only are the trees important for the protection they give from the direct rays of the sun, but they are also important from the point of view of soil fertility, which they assist by the return to the soil of organic matter in the form of leaf fall and loppings, and also the action of their roots which by breaking up heavy sub-soil layers, enable the tea bushes, which are naturally weak-rooters, to explore greater depths of the soil. Throughout the Nilgiris, the silver or silky oak, *Grevillia robusta*, is a common shade tree in tea. If left untouched, it grows to a considerable height over a number of years, but is frequently to be seen pollarded at about 20 to 30 ft. above the ground. This makes the tree easier to control at lopping time. At lower elevations, the high shade provided by the silver oak is to some extent replaced by that provided by a number of *Albizzia* species, notably *A. stipulata* and *A. moluccana;* the latter, because of its shallow rooting habit, is not now much in favour as it has been demonstrated during recent years, that in times of drought, it competes severely with tea for available soil moisture. As an adjunct to this high filtered type of shade, low shade is frequently to be found in the tea on the Nilgiris. At higher elevations, above 5,000 ft., various species of *Acacia* grow extremely well. These trees, though surface feeders and liable to compete with the tea both for water and nutrients, do not become a major problem if they are removed every 10 or 15 years. The bark

from many of these varieties of *Acacia* provides a rich source of tannin and at present good prices are to be obtained for wattle bark. Further, timber from the old shade trees makes excellent firewood both for domestic use and for use in the factory driers. The dadap *(Erythrina lithosperma)*, a close relation to the Indian Coral tree, is commonly grown at the lower elevations. This leguminous tree with its broad leaf, its rapid growth rate, its ability to stand almost continuous lopping, and its ease of propagation by means of stump cuttings, makes a very popular type of shade. The canopy of low shade is usually maintained by pollarding and lopping at about 12 to 18 ft. above ground level. In addition to the shade trees already mentioned, it is common to find various species of shrubby leguminous plants grown in the tea, particularly in newly planted areas, where they serve both as protection from the drying sun and also as a source of mulch. The most common species of green manure shrubs are *Tephrosia candida* and *Tephrosia vogelii*, (somewhat out of favour because of their attractiveness to eelworms), and a number of varieties of the *Crotalaria* species, particularly *C. anagyroides* and *C. striata.*

MANUFACTURE

From the field, the flush is transported to the factory where it undergoes the mechanical processes associated with the manufacture of the finished product. It is frequently said that " manufacture starts in the field " and unless care is exercised to see that only the right leaves are taken from the bush, that all extraneous matter is removed from the baskets and that transport to the factory is expeditious and carried out so as not to impair the quality of the leaf, the final quality of the tea will suffer. The quality of the made tea reflects greatly the type of plucking. There are three types of finished tea, *Black, Green, Oolong* tea, but as the two latter types are not commonly produced in South India, we will consider only the more usual *Black* tea.

On arrival at the factory, the leaf undergoes a period of natural dehydration or *withering* in specially constructed sheds or lofts, with controlled air temperature in some cases.

When the leaf is in a suitably flaccid condition, it passes to the rolling room where machines roll the leaf to break up the cells and liberate the sap containing the enzymes necessary for fermentation. It is during this process that the leaf acquires the '*twist*' which characterises the final product. From the rollers, the leaf is moved to the fermenting floor where it is spread evenly and undergoes a period of fermentation or more correctly, oxidisation. This has actually commenced during rolling but after a period on the fermenting floor, the leaf takes on a bright copper colour. It is now ready for '*firing*' which is the process of drying the leaf in a special oven called a '*drier*' at a constant temperature and for a set period. Successful '*firing*' depends upon the careful and precise regulation of the speed and temperature of the drier. The leaf emerges from the drier in its final form, except for sorting and such sifting and cutting as may be necessary.

There are two grades of tea, the '*Broken*' and the '*Leaf*' grades. The former comprises the smaller tea sifted from the bulk or resulting from cutting; the latter represents the larger grades of tea left after the removal of the *Broken* grades.

The more common *Broken* grades are *Broken Orange Pekoe, Broken Pekoe* and *Fannings,* while the customary *leaf* grades are *Orange Pekoe, Pekoe* and *Flowery Pekoe.* The *Broken* grades usually give a darker liquor and a stronger tea, while the *leaf* grades produce lighter coloured and less strong infusions. In addition a considerable amount of '*Dust*' is produced which gives extremely strong infusions.

PESTS AND DISEASES

Although there are a number of pests and diseases of tea, South India has generally been very fortunate until recent years in that no serious wide-spread disease or pest has been manifest. Usually under conditions of monoculture, crops are open to the risk of widespread disease which it is difficult to restrict, owing to the large contiguous areas of permanently established susceptible plant material. Numerous examples come readily to mind, such as the leaf diseases of coffee and

rubber, the virus disease now so widespread among the cocoa growing areas of West Africa and diseases of the banana in the West Indies.

Until the arrival of *Blister Blight*, a leaf disease of tea caused by the fungus *Exobasidium vexans*, Masses, which was first reported in South India in 1946 in the Mundakayam area of Travancore, no widespread disease or insect pest of economic importance had been known. A certain area of Travancore had been subject to attack by the Tea Mosquito Bug (*Helopeltis spp.*), but its presence in sufficient numbers to cause severe crop damage was restricted to that area. But in the case of blister blight, within five months of its appearance in Mundakayam however, it had spread on the prevailing winds to all the other tea districts of South India and the incidence of the disease reached serious proportions. Both at the Tea Research Institute of Ceylon and the Central Research Station, Buitenzorg, Java, in which areas blister blight is now established, as well as in our own Experiment Station at Davershola investigations into control measures have been energetically undertaken. We now know that tea coming back from pruning and in nurseries and new clearings can be protected by the use of certain fungicides. We know, too, that by a judicious programme of controlled shade and by changing the times of pruning, so that the new growth which is most susceptible to attack, is made during the dry period when the risk of blister blight is at its minimum, conditions can be created to minimise the severity of the attack. The problem that remains to be solved is to devise an economic method by which mature tea, that is to say tea in plucking, can be protected from this scourge and it is on this aspect of control that our attention is now focussed.

We have had some considerable success in South India in the control of the tea mosquito bug with insecticides and *Helopeltis* attack need no longer be feared.

RESEARCH

In other fields such as methods of cultivation, manuring etc., research is on the march and particular

attention is now being paid to development of proper technique of vegetative propagation. A field of tea presents a very mixed population, bushes differing among themselves in genetic constitution. This leads to diversity of response to environment, for example, manuring or drought conditions, and differences in character such as yield, cup qualities and disease resistance. Vegetative propagation by cutting, that is to say, the removal of a section of the shoot from a selected bush and planting it in such a manner that it forms roots and grows into a new bush, is becoming increasingly popular. Bushes with required characters, such as high yield, good quality and a high degree of resistance to blister blight, which is of particular importance at the moment, can be selected and propagated by this method with the certainty that under similar conditions of environment, the progenies will react just like the parent plants. Unfortunately, however, *Camellia sinensis* is not a plant in which vegetative propagation is easy and in many cases those plants which exhibit desirable qualities are among the hardest to reproduce vegetatively.

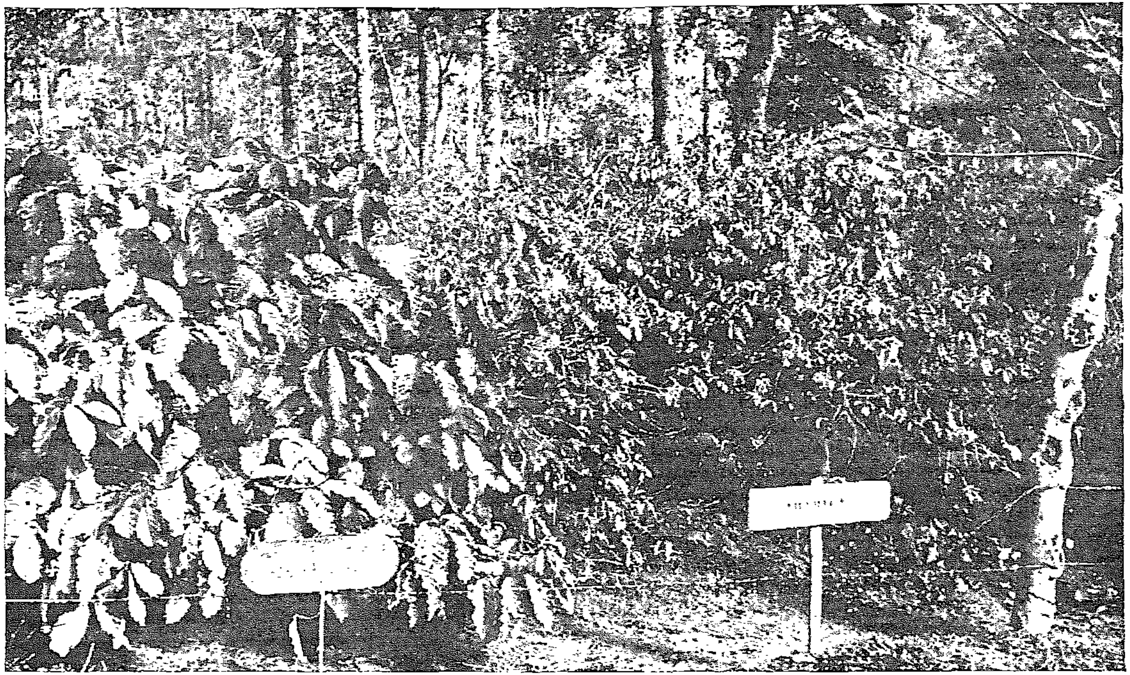
It is difficult to point to any specific advances in the field of cultivation which can be attributed to scientific investigation; the systems now in vogue have evolved gradually over a period of years and the high yields and excellent conditions of many of our Nilgiri estates testify to the high standards of cultivation employed. There have been advances, of course, in the techniques of manufacture and particularly in the equipment and design of factories.

ESTATE LABOUR

Perhaps the greatest changes in the industry have occurred in the field of estate labour, a force which numbers some 1,85,000 in South India. Arising from the Government of India Labour Investigation Committee Report of 1946, the first Tripartite Conference was held in January 1947 to consider the conditions of plantation labour and to make necessary reforms. These included increased maternity and sickness benefits, some changes in the

conditions of employment such as no deductions for damp leaf, cessation of the practice of levying fines and a limitation on the employment of children. Children under 10 years of age were not to be employed and if possible, the lower limit was to be 12 years. Direct welfare measures included the setting up of a sufficient number of creches on estates and the provision of films for adult education where practicable. Standards of housing too have improved considerably and so have the provision and equipping of estate hospitals and schools.

In these and other ways has the industry advanced over the last 100 years until today when this small area of India is producing some 2½% of all the tea grown in the country.



Plants of two types of coffee, "Robusta" (left) and "Arabica" (right).

2. COFFEE INDUSTRY IN NILGIRIS

by N. B. ATHREY, Coffee Planter, Nilgiris,
and Member, India Coffee Board

INTRODUCTION AND EXPANSION ON THE NILGIRIS

The history of the coffee industry in South India started with the very commencement of a plantation industry in this territory and King Coffee held the field wherever plantations were opened, till disease, uneconomic prices or unseasonal conditions, or the gold rush, forced coffee out to be replaced by tea, rubber, potatoes, or abandoned mine shafts.

The East India Company started an experimental plantation of Arabica coffee in Anjarakandy near Tellicherry in 1799, under the management of one Mr. Murdoch Brown, and subsequently left the plantation to him. Mr. Brown seems to have made a success of this venture, and he came to be known as 'Anjarakandy Brown'. Plants taken from Anjarakandy were planted in Manantody in Wynaad in 1825 by one Captain Bevan, when his garrison was stationed there, and these established themselves so well that coffee seeds were distributed to the local cultivators for planting by the then Collector of Malabar.

The first plantation in the Nilgiri plateau was started in 1838 by one Mr. Dawson of Coonoor, and another experimental plot was opened at Kalhatti on the Seegur Ghat in 1839 with seedlings from Manantody. The next expansion of area under coffee was round about Kotagiri by Mr. Cockburn in 1840, when Balahardar Estate on the Kotagiri ghat, Hardathorai near Kotagiri, and Banahatti in Hulical, were opened. The famous Ouchterlony Valley estates were opened in 1850, and at this time a controversy seems to have raged as to the superiority of the eastern slopes of Nilgiris for coffee over the western slopes. However, Major Ouchterlony in his survey report of 1847 had already mentioned the fact that the western slopes were equally suitable for coffee. Besides this, enterprising planters from Ceylon took up coffee cultivation

on the western slopes, and in fact on these slopes, the growth was even more luxurious than on the eastern slopes. But it could not be denied that the coffee from the eastern slopes had a peculiar fine flavour in the cup. By then, plantations of coffee trees were scattered all around the hills, principally situated on the slopes descending to the plains, giving a visitor an idea of the elevations suitable for the growth of coffee.

In 1866—'67, the area planted up with coffee was returned as 13,500 acres yielding 3½ million pounds of crop. The Eastern, Southern and North-Western slopes proved the most favourable to the growth of coffee, the Kundahs to the west being too much exposed to the South - West monsoon and the Northern slopes too dry. The subsequent development was fairly rapid and, though statistics have got to be accepted with a certain amount of reserve, it is said that the peak of prosperity was reached in 1879, when the area cultivated in the whole district was said to be 25,000 acres and the crop about 4,500 tons. In fact the cultural conditions prevailing then were said to be extremely favourable in the district and the author has heard from several old men who knew what they were saying, that it was enough to pull out self-sown seedlings under old coffee trees and plant them in the open by dibbling with a pointed stick and make a thriving coffee estate within three years. The yields were also said to be heavy, though often erratic. It is rather strange that there is no mention of shade for coffee in all the old references and the Ceylon practice of coffee without shade, was the order of the day, as against the Mysore or Coorg practice of growing coffee under shade. Subsequently however, the appearance of the leaf disease, *Hemeleia vastatrix*, and the Green Bug, *Lecanium viride*, more or less forced the planter to grow shade. Previous to this, a practice had been prevalent of covering coffee trees with *samai* hay during frosty weather. Some were growing in the midst of coffee plantations castor trees, and supplementing their income by the sale of castor seeds; and others again fruit trees like oranges or jacks, all this with a view to supplement their income but not with a view to grow coffee under shade, as it is understood in modern coffee culture.

According to the Nilgiri Gazeteer, "insect pests and diseases in the plantations, low prices resulting from increased production in other countries, and the dissipation of much energy in the vain search for gold in Wynaad boom of 1879–'82 caused a reaction; and in 1884—'85 the exports were 3% less than in 1883—'84 and their value 13% less, prices in London having dropped from £ 3—5—0 and £ 4—0—0 a cwt. to between £ 2—15—6 and £ 2—19—0" and "it is only however by rigid economy and constant care that coffee estates now pay, and the industry is in anything but a flourishing condition. Scores of plantations in the Wynaad have been entirly abandoned and relapsed into jungle, and others are in the hands of natives who merely pick such crop as the trees will give with the minimum of cultivation".

Low prices and the resulting reglect of plantations produced favourable conditions for havoc by the coffee leaf disease, *Hemeleia vastatrix*, and areas which had produced heavy yields in the lower slopes were the worst sufferers, the drier northern and higher slopes not having been so badly affected. That was during the turn of the century, and in 1907 Green Bug, *Lecanium viride*, made its debut in an epidemic form and devastated plantations, especially those that were grown in the open without shade; and the damage from this epidemic is said to have been very heavy, as all the coffee in the higher elevations suffered. It was only in the boom of 1926—'29 that new plantings revived the industry by the systematic planting of shade which developed the fungus that controlled the bug.

It was in 1910 that the Nilgiri Planters' Association at its meeting held on 23rd September passed a resolution, "that a request be made to Government through the Collector to grant a piece of land at a suitable elevation between 3000 and 4000 feet for experimental purposes under the advice of the Planting Expert, (Mr. Rudolph Anstead), for the hybridization of coffee and rubber for proving what products may be successfully grown by planters in this district". Presumably the reduction of crop on account of leaf disease was realised, and as certain hybrids justified the claim for immunity, the planters thought that an experimental plot in charge of the Curator of the Botanic Gardens (Mr. F. H. Butcher) and

under the guidance of the U. P. A. S. I. Scientific Officer, Mr. R. D. Anstead, would produce an effective answer to their cultural problems. A plot of land about five acres in extent was chosen on the Coonoor ghat road, on the understanding that the various district associations interested in coffee would contribute the recurring expenditure. The reason why this venture was put in cold storage has not been fully explained but one explanation is that 'Kents' became popular, and was resistant to the local strain of leaf disease, and thus the enthusiasm for hybridization waned. But the fact that the Curator of Government Gardens and Parks was associated with this venture marks the great appreciation of the part played and the influence wielded by the Botanic Gardens, both at Ooty and the Lalbagh, Bangalore, in the supply of seeds, plants and information on shade in coffee culture.

Coming to the present times, the area under coffee in Nilgiris is about 22,199 acres comprising 21,193 acres under Arabica and 1,006 acres under Robusta, and produces about 2,000 tons per annum. The average yield for the district is about 214 pounds which is low compared to Anamallais or Coorg. The handicap the industry suffers is the low net yield compared to the sister plantation product tea, or the field crop potato. Coffee, being a fruit crop, needs dry weather during the wintering and blossoming period, and rains during the growing period. Unfortunately this is not invariably the case, and as it has happened during the last five or six years, conditions have been the opposite, with the resulting distress in the industry. There has not been much of new extensions during the last decade in spite of the rise in prices, as the seasonal conditions have not been very favourable for the grower to take advantage of the higher prices and increase his acreage. But there have been recently signs of increasing care and attention being paid by filling in vacancies, manuring, pruning and regulation of shade which go with economic crops. But the labour legislation and higher minimum wages, now threaten to increase production costs still further and to weaken the industry's competetive position in the world markets. Nilgiri coffee bean is known for its fine blue colour, and attrative liquoring properties,

which command a premium in the London market, and is in great demand for blending with other coffees.

CULTURAL METHODS

The plants are raised in beds or baskets in a nursery, usually from Kents Arabica seed, as the plants from these selections are generally immune from the strain of *Hemeleia* which is prevalent in the district. The other system of raising plants from leaf cuttings from garmandizers in propagation chambers has not yet become general, as it is still a new innovation. Recently selections such as S.288 from the Balehonnur Experiment Station which are said to be completely immune to the various strains of leaf disease and hence do not need spraying, are becoming popular. These Balehonnur selections are claimed to give phenomenal yields of nearly 10 cwts. per acre, and perhaps may be an answer to the problem of increasing cost of cultivation. In a year or a year and-a-half after the seeds are sown in the beds or baskets, the plants are ready for transplanting in the field, and are planted in pits dug about six feet apart in the case of Arabica, and nine feet apart in the case of Robusta. There is also another practice of allowing the coffee plants to grow for two to three years in the nursery itself and then planting them out as stumps, as these stumps can withstand dry weather immediately after transplanting better than young seedlings. Proper and adequate drainage and aeration of the soil and prevention of soil wash, and envelop forking of alternate rows with shade leaf mulch and chemical manures, are practices copied from the tea planter. The trees are topped at three and-a-half to four feet according to the slope of the land, and a single stem with its primaries and secondaries is the usual frame work which bears the coffee crop. Experiments for growing coffee under the multiple-stem system of training as against the single-stem system, are being conducted at Balehonnur, as the multiple-stem system is said to give higher crops at less cost. Years ago, some planters did adopt the multiple-stem system in another district, but learnt to their cost that while this type of training the trees gave heavy yields for a few years, the crop tended to drop to uneconomic

levels afterwards. The Kenya method of periodically renewing the stems is being tried now. The peculiar feature in this district is the need for regular pruning and handling every year, as otherwise the trees get matted with new shoots; and because the old branches (secondaries and tertiaries) do not dry off after cropping as they do in the lower elevations in Mysore and Coorg, the trees do not bear much of a crop. There is a tendency to overdo this operation, which caused the reaction of leaving the trees alone specially during slumps, and the planter has now realised that too drastic as too little pruning is not conducive for the production of average crops.

CROPPING

The trees start bearing after the third to fifth year after planting in the field, except in the case of stumps which start bearing earlier, and as the estates range from 3000 to 6000 feet above mean sea level, the higher the elevation the slower the trees come to bearing, and the longer is the period of ripening, which extends from November to April. Great care is taken to pick only ripe berries, and the picking rounds are repeated often to ensure this, which increases the cost of picking in the higher elevations. Almost the whole of the crop is converted into parchment by pulping and washing and is the cream of Indian coffee, and only the tail end of the crop which it is not economic to pulp is dried into cherry.

SHADE

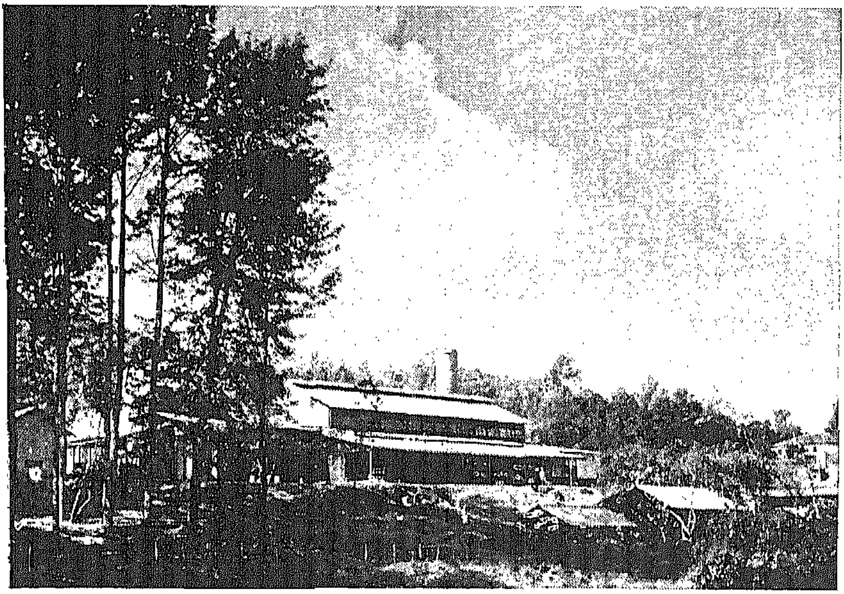
The modern practice of growing coffee under shade is only of recent origin in this district, after the visitation of the green bug, and the usual shade, *Grevillia robusta* which is lopped and maintained as a high shade, with Dadaps-*Erythrina lithosperma*, as a low shade. *Grevillia robusta* was popular because of the heavy litter of mulch which prevents sheet wash, but the disadvantage is that the mulch decomposes very slowly, which is not an advantage in a

surface feeder like coffee. Varieties of Ficus, Albizzia, and other local jungle trees are also grown as shade, and the purpose that shade serves in keeping the temperature even and humid by a chequered canopy, and in preventing the coffee from producing too much of a vegetative growth at the expense of crop, was not well understood until very recently. The advantage of using a high leguminous shade like "Kadu Bage" (a species of Albizzia) as in Kil-Kotagiri where the coffee underneath is very luxuriant, and for that matter even under dadaps, as against coffee under Grevillea, was not realised or understood well enough to be practised. It may be said that there is a crying need to catalogue the various species of shade trees which will suit the various situations and aspects, and to provide the seeds through the liaison officers of the Indian Coffee Board. For this purpose the help of the forest department as well as the Government Botanic Gardens, Ootacamund, can also be utilized, for there is no better or cheaper experimentalist than the coffee grower, and the present haphazard and costly method of trial and error can be replaced by more accurate data. Shade in coffee culture is of major importance lately, as the ravages of stem borer have increased, perhaps due to the erratic rains and the long periods of dry weather. No effective remedy has yet been discovered against this pest, and the only solution is to grow the correct shade which will mitigate its ravages and at the same time let in enough sunlight to produce optimum crops.

RESEARCH

The main line of research at the Balehonnur Experiment Station in Mysore State is to produce a uniform high-yielding strain of coffee, which is resistant to coffee leaf disease, *Hemeleia Vastatrix,* as the loss of crop due to its ravages is very heavy unless coffee is sprayed, and spraying is a very costly operation and is dependent on an adequate supply of water. The other important investigation is to observe as to what is the adequate dosage and what are the suitable components of manure for coffee, as up till now the present dosage and kind of manuring has not shown a significant

difference as against control, and it is necessary to find out why India does not produce economic crops to compete with the other quality-coffee producing countries of Central America, though she produces some of the finest coffees of the world. Let us hope that we shall find the answer in the near future.



A view of the Government Quinine Factory, Naduvattam.

Dumping green cinchona bark for drying in the sun.

3. CINCHONA INDUSTRY IN THE MADRAS STATE WITH PARTICULAR REFERENCE TO THE NILGIRIS

by A. Y. SWAMY, Director,
Cinchona Department, Madras

INTRODUCTION

Cinchona, the source of quinine has assumed great importance during the last one hundred years and particularly in the last quarter of a century. In India the tree was first introduced in the year 1860 when its acclimatization and propagation were taken up at Dodabetta under the auspices of the Government Botanical Gardens at Ootacamund. The naturalisation of this tree in this country and its growth into a plantation crop had long ago become accomplished facts and the Government Botanical Gardens at Ootacamund, as we shall see presently, have played a great part in the early stages in the evolution of this industry to its present status.

HISTORICAL

The genus Cinchona is a native of Peru and Bolivia in South America. The medicinal value of the bark of the tree is said to have been known to the Incas, the aborgines of the areas as early as the year 1600. It is believed that they used steeps of this bark for curing themselves of chills and ague. As to how the febrifuge virtue came to be discovered makes very interesting reading. One legend has it that the water of a particular lake in these wilds had curative property, as those that drank of it were found to be cured of fevers. The more intelligent among the people however soon came to understand that the medicinal property was endowed by the bark of a tree which had fallen in the river; another legend has it that the Pumas or South American lions used to chew the bark of the tree to rid

themselves of fevers. The property of the bark then came to be known to the Spanish Jesuits who were then serving in Peru, and through their good offices and those of the Countess of Cinchon, the wife of the then Spanish Viceroy in Peru, after whom the genus is named, the bark found its way into civilisation in the year 1640. In Europe the bark was continued to be used in the form of a decoction until 1820 when French chemists isolated from the bark the alkaloid quinine which is so very lethal to the malaria parasite. In 1852 extraction was started on factory scale by Thomas Whiffen.

In due course the bark had attained such great popularity in Europe that regular trade in the commodity came to be established. But indiscriminate felling and exploitation of the Cinchona forests started with such extravagance at this stage that it looked as if the supplies of this valuable bark would cease quickly. However in 1780, Condamine a French botanist raised a warning voice against such indiscriminate felling and suggested to his Government that very early steps should be taken to introduce the plant in other parts of the world.

FROM THE OCCIDENT TO THE ORIENT

In the year 1839, Forbes Royle first recommended the introduction of this tree into India, pointing out that the Nilgiris would be a suitable area for experimentation, but no heed was paid to his proposals. Later, in 1852 the Dutch under Hassakarl undertook an expedition to Peru and after collecting several species of Cinchona plants arrived in Java in 1854 and started the cultivation of these plants. In 1856 Royle again suggested to the East India Company that the introduction of Cinchona into India should be taken up without further delay, and in 1859 under their auspices Clement Markham undertook the difficult task of scouring the wilds of the Andes for Cinchona plants and seeds for introduction into India.

After a strenuous and painful expedition and tedious journey, Markham returned to India in October 1860 with his small but precious collection of seeds and plants of Cinchona

and entrusted to W. G. McIvor, the then Superintendent of the Government Botanical Gardens at Ootacamund, the difficult and critical task of converting the wild trees of the Western hemisphere into cultivated ones of the Eastern. McIvor was probably the best suited person to accomplish this task, with his wide practical experience as a horticulturist and his knowledge of the climatic conditions and soils of the Nilgiris. As reference to literature and subsequent results indicate, McIvor brought to bear on his work very great skill and professional competence and it is due to his classic work that Cinchona came to be established in this country.

Soon afterwards McIvor received another consignment of seed from Pritchett, another botanist explorer. After a detailed survey of the hills, McIvor selected Dodabetta and Naduvattam as the sites for Cinchona experimental stations as they were suitable from the point of view of climate and the native habitat of the plant. McIvor set himself to the great undertaking with such earnestness and zeal that within a very short space of time, he was able to introduce in Cinchona culture the most ingenious methods of germination and aftercare of the plants. He also succeeded in evolving a suitable technique for propagation of the tree by layers, and by cuttings with the aid of hot frames.

The first experimental planting out was done in the spring of 1861 at Dodabetta. Early in January 1862 the formation of a nursery was taken up at Naduvattam and about one acre was planted that year. About the same year McIvor exchanged with the Dutch Government at Java some of their plants with those raised by him at Dodabetta, thus introducing into the country some more species for cultivation; he also sent a small number of his plants to Calcutta with a view to establish Cinchona plantations at Sikkim, and a small quantity of seed to Ceylon for starting the industry in that Island. In 1863 Dr. Anderson also obtained some seed from McIvor at Ootacamund and opened plantations on the Mungpoo ridge in Bengal. By about the year 1866 the expansion had gone apace and as much as 507 acres were under Cinchona, 152 at Dodabetta, 284 at Naduvattam and 71 at Wood Estate.

The very successful performance of the Cinchona in the Nilgiris Hills now became an incentive to private interests and numerous plantations of Cinchona sprung up in the hills. Under orders of the "Home" Government (British Government), seeds and plants were freely given by McIvor, and Balmedes was opened in 1868 with 60 acres. Col. Denison planted 400 acres at Ossington and a large number of other interests who purchased land in the Nilgiris under the Wasteland Rules of 1863 also undertook the cultivation of Cinchona. Plantations also came up in Coorg, Shevroys, Palanis, South Kanara and Tinnevelly with the material obtained from the Government gardens. Thus it could be said that most of the Cinchona plantations in this country and Ceylon, both Government-owned and private-owned, owe or owed their existence to the experimental station started in the Botanical Gardens long ago.

By 1880 the acreage of the Government plantations had gone up to 847, with 320 at Dodabetta, 301 at Naduvattam, 72 at Wood Estate and 154 at Hooker.

Thus was in short the source of a universally employed drug, used by both rich and poor alike, made secure for India. The transplantation of this tree from its home in South America serves as an illustrious example of what could be done to combat the effects of indiscriminate and reckless exploitation of the bountiful resources provided by nature.

As plantations grew up, necessity came to be felt for a chemist with necessary equipment to analyse the bark that was being obtained as well as to manufacture the alkaloids from the bark, and in 1870 Broughton was appointed as Chemist and he started a small Government factory at Naduvattam, for manufacture of febrifuge, which became the nucleus of the present Quinine Factory.

RUIN OF THE CINCHONA INDUSTRY

Planting by private enterprise however went ahead, and by 1880 India had 10,000 acres (Madras alone with about 2,500) compared to 33,500 of Ceylon and only 7,500 of Java.

McIvor's great career ended in 1876 with his death and thereafter it is understood the plantations came to be sadly mis-managed resulting in temporary set-back to the Cinchona industry in this country.

Due to lack of import restrictions however, between 1880 and 1890, there was so much Ceylon bark dumped into India that the Indian industry suffered a great crash and nearly 5,000 acres went out of cultivation in preference to tea and coffee which were more paying. Cinchona industry in Java, however, was able to weather the storm of over-production and glut due to the clever scientific control that used to be exercised from the very early stages of the industry and due to the avenues for export of bark provided by the Dutch Government of Java. The formation of the Kina Bureau of Java in 1913 further strengthened the Java industry, and in 1938, just before the commencement of world war II, she had come to occupy the position as the premier quinine producing country of the world, supplying nearly 97% of the requirements and about 70% of India's consumption at a price in the Indian market lower than that of the Indian product itself.

RESUSCITATION

When rumours of the possible retirement of Java from the field reached the country in the first decade of this century, the necessity for the resuscitation of the industry to keep up the supplies of the much needed quinine in India came to be realised. In 1916 attention came to be directed to the need for embarking on further expansion of the plantations. Forest lands in the vicinity of the estates at Dodabetta and Naduvattam were examined and rejected in favour of a large block of forest land in the Anamallais. In 1916 a scheme for planting 22,000 acres of virgin forest land in these hills was approved and it was ultimately taken up for execution in 1925.

Between 1925 and 1930, an area of 939 acres was planted on these hills with seed and plant materials obtained from the Nilgiris. No further planting was done till 1938. When the Congress Government took over the administration

of Madras Province in the year 1937, they anticipated the possibility of Java supplies of quinine being cut off by the war that was then threatening. As a result of the keen interest taken by them, expansion of Cinchona plantations was taken up again and today the Anamallais have a total acreage of 7,125 under Cinchona.

THE MADRAS CINCHONA DEPARTMENT

The Cinchona Department of Madras, needless to say, was born out of experiments done in the Nilgiris. Today it is an independent unit of the Development Department. Its administrative and technical head is the Director, with his headquarters at Ootacamund. The Department is treated as a commercial concern and has a capital outlay of 120 lakhs. The Department is also financed by the Government of India for expansion and research purposes.

The institution has about 180 officers and staff working and employs daily about 6,000 labourers in plantation and factory works. The Departmental plantations are located in the Nilgiris and Anamallais. The Nilgiris plantations consist of seven divisions and are under the charge of a Superintendent. The total acreage is about 2320. The Dodabetta Plantation has the highest elevation viz. 8,000 ft.

Manufacture of Cinchona products is carried out on modern lines at the Quinine Factory at Naduvattam. This factory is under the Manufacturing Chemist. It is fed with bark obtained from the Departmental plantations in Nilgiris and Anamallais and from private sources in these hills, in Coorg and in Singampatti. About 20,000 pounds of quinine sulphate and 10,000 pounds of other alkaloids are manufactured annually, the peak capacity being 60,000 pounds of quinine sulphate and 30,000 pounds of febrifuge.

Quantities of the various finished products manufactured by the factory during 1950 – '51 are given below :–

1.	Quinine sulphate, powder and tablets	lbs.	12,843
2.	Quinine bihydrochloride ...	,,	2,388
3.	Totaquina, powder and tablets ...	,,	86
4.	Cinchona febrifuge, ,, ,, ...	,,	4,788

A new quinine factory on modern lines is under construction in the Government Cinchona Plantations. Anamallais at a cost of thirty lakhs and capable of manufacturing 80,000 pounds of quinine sulphate per year. This factory is expected to commence its work very shortly.

THE CINCHONA TREE AND ITS CULTIVATION

A very brief description of the Cinchona tree and its cultivation as carried out in the Department will be of considerable interest at this stage.

The Cinchona is a beautiful evergreen tree belonging to the natural order Rubiacae and growing to heights of 30 to 35 feet and diameter ranging from 6 to 12 inches. The trees are sparsely branched. The leaves are of a great variety of shapes and sizes generally, with shining surface of bright green traversed by crimson veins. The flowers are produced in clustered panicles and are generally of cream to crimson colour. The flowers have a delightful fragrance. Quinine is extracted from the root, stem and twig bark. The root bark is richer than the stem bark or the twig bark, but the quantity obtained is lesser, being only about one-third of stem bark.

Species under cultivation

When the plantations were originally started, *Cinchona officinalis, Cinchona ledgeriana, Cinchona calisaya, Cinchona succirubra, Cinchona robusta* and *Cinchona eurutusinga* were the main species grown, but as a result of open pollination, considerable hybridisation has taken place rendering the classification difficult. The ledgers and ledger hybrids in general have given richer bark than the other species.

Elevation and Soil

Cinchona requires an elevation ranging from 3,500 to 8,000 feet for optimum performance. The Cinchona likes a

deep well-drained loamy soil, rich in humus and with a pH value of about 5 to 6. Hence forest lands such as those obtained in the Anamallais are best suited for its cultivation.

Spacing

4 feet x 4 feet is the spacing normally given, but in recent years 3 feet x 3 feet spacing has been adopted to minimise demand on new land.

Propagation

Propagation by seed is adopted for large-scale work while vegetative methods are employed to multiply very high quinine-yielding strains, in a true to type manner.

Seed, seed sowing and nurseries

A pound of Cinchona seed gives about one lakh of plants for field planting.

The seeds are sown in February to May on raised beds made up of a mixture of leaf mould and sand and formed under jungle leaf or grass pandals. One ounce of seed is sown in about 60 square feet. The seeds take anything from 25 to 40 days for germination depending on the elevation, lesser time being taken at lower elevations. Judicious watering and lighting are necessary to ensure optimum germination and growth. When the plants have formed about 4 pairs of leaves, which will be after 120 to 180 days depending again on elevation, they are transplanted 4 inches apart in forked beds under fern or jungle leaf. About one third of the stock required for the annual planting is transplanted in baskets about 4 to 5 months before planting.

Vegetative Propagation

The methods of vegetative propagation which have given best results are patch budding, and through cuttings and layering.

Patch budding has on an average given 85% success. Best results are obtained during March to the middle of June. Budding is done either in nurseries and the plants set out in the plantations, or in the plantation *in situ* when the plants are one to two years old. Budding on copice emerges has given higher success and quicker growth.

Cuttings are made to root by cincturing and etiolation and give equally good success. The shoots are treated in March to June and severed and planted out in the nurseries after 50 to 65 days. The East Malling method of layering with a few modifications made to suit the crop in question is also very successful, each stool giving annually as much as 100 to 120 shoots in 2 or 3 croppings.

The cuttings that are severed in June-July could be planted out direct in the field without being passed through the nursery, but this method is fraught with considerable risk as the final success of the plants depends largely on the rains being well distributed.

For large scale planting it is not always possible to depend upon the mother trees for material for propagation as the trees are generally sparse. To meet this limitation, separate clonal stands are raised for supplying material continuously to handle large schemes.

COMMON DISEASES AND PESTS

"Damping Off" is a common disease in seed beds particularly at lower elevations. In the nurseries, the plants are affected by collar and root rots. The incidence could be prevented by proper attention to drainage, and prophylactic spraying with Bordeaux mixture. Collar and root rots affect cinchona in the field also, but control by spraying is rendered difficult by the vastness of the area or difficulty of access. Here again, the disease could be prevented by attention to drainage, shade and cultivation.

Minor damage is caused in the nursery and in the early years in the plantation by Helopeltis and Sphinx caterpillar.

RESEARCH

Towards the middle of 1942, the Government sanctioned the formation of a Research Section for the Department for carrying out vegetative propagation on a large scale and for conducting research on commercial aspects of Cinchona cultivation. The section has its headquarters at Anamallais under a Gazetted Officer.

The results obtained in the field of vegetative propagation have been encouraging and such propagation is being done on large plantation scale. This section has now about 120 acres in the Anamallais and Nilgiris under clonal stands and experiments alone and 160 acres planted for bark exploitation. The details of the methods adopted and technique employed have already been touched upon.

The other main items of research conducted by the section are on improvement in nursery technique and determination of the best method of harvesting, the optimum age of coppicing, the optimum number of coppicings to be given and the degree of thinning to be done at different stages to get maximum yield of quinine and bark.

In 1948 the Government sanctioned a scheme for manurial trials on Cinchona for increasing the yield of bark and quinine and for rendering used land suitable to receive another crop of Cinchona. The Propagation section is in charge of the scheme. The trials are in the second year of working.

IMPORTANCE OF QUININE TO HUMANITY

Malaria has been described as one of the greatest scourges of mankind and has caused much greater loss in lives and materials than even world wars. No single disease is said to cause greater mortality than malaria. In India, more than one million lives are taken toll of annually, not to speak of another million which, weakened as a result of malaria, fall easy prey to other diseases like typhoid and tuberculosis. It is essentially a rural disease in our country and the loss in efficiency and manpower to the agricultural production of the country could be easily imagined. It is

believed by eminent men on the basis of comprehensive data that if adequate curative treatment is given for this single disease, India can be converted in a single generation to one of the most prosperous and healthy countries in the world.

The value of quinine as a curative to malaria has been known since times immemorial, and even to-day expert medical opinion regards quinine as a safe and sure remedy for recurrent malaria. The special feature of this drug is that it is a natural product and that it has withstood the test of time and superstition in different parts of the world through the ages. And to us, it is of special interest because this disease is widely prevalent in our country and Cinchona cultivation has become a national industry today.

4. THE CULTIVATION OF TAN BARK WATTLES ON THE NILGIRIS AND THEIR ECONOMIC IMPORTANCE

by K. N. RAGHAVAN NAIR
Provincial Silviculturist,
Ootacamund

INTRODUCTION

According to the recent estimates, there are 639 million heads of cattle in the world out of which a little more than one third are in India. Slaughtering nearly 20 million heads of cattle every year, India is the largest single producer of cattle hides and according to the Hide Cess Committee's report, the average export of tanned leather from India for the decade ending 1937 to Britain alone was 1,16 58,000 sq. ft. The tanning industry, though not as well established as it ought to be, has recently assumed considerable importance not only as one employing 10 to 15 lakhs of people but as a major dollar earner. But the industry has to overcome several obstacles before it is well established. Ever since its beginning, the lack of timely and steady supplies of the necessary tanning materials has been a serious problem. It is true that we have several tanning materials. Our forests contain more than 300 vegetable tanning materials, the most valuable among them being the myrobolans *(Terminalia chebula)*, babul *(Acacia arabica)*, avaram *(Cassia auriculata)*, konna *(Cassia fistula)* and the divi-divi pods *(Caesalpinia coriaria)*. But the supply position has never been satisfactory. Moreover, with the exception of myrobolans, the tanning content of our indigenous materials varies from 10—18% and compared to other imported products such as Quebracho and Valonia, it is low and consequently uneconomical to use. Besides this, as the collection of the tanning materials has been mostly in the hands of illiterate forest contractors whose main object has been to earn a quick profit, there has been no proper grading of the material and the manufacturer could never rely on its tanning content.

However, the discovery of chrome tannins early in the present century gave a great fillip to the expansion of tanning industry. But it was soon realised that while chrome tannins had several advantages, they did not give the same finish to the leather as vegetable tannins and this was particularly so in the Kip tannage of South India. During the first world war and a few years that followed, the Indian tanneries were mainly depending on the indigenous tanning materials and struggling hard to keep the industry on a profitable level.

It was at this stage that South Africa first marketed wattle bark as a tanning material and for one or two years it was not at all liked by the industry. But the advantages of wattle bark, over the indigenous tanning materials, were so many that within the course of ten years it became very popular and during the last world war, almost all the Indian tanneries switched on to wattle bark for tanning leather and East Indian Kips, leaving avaram *(Cassia auriculata)* for skins. South Africa had carefully studied the conditions and requirements of the Indian markets and paid particular attention in catering to the needs of the several factories started all over the country. The bark was properly graded with a guaranteed tannin content and what was more, the supplies were steady and available in any quantities. For the greater convenience of the industry, the bark was put on the market both as powder and extract, the latter being a concentrate containing 60 to 63% of available tannin. In addition to all this, wattle bark is one of the richest vegetable tanning materials in the world and no wonder that it has been the first choice not only in India but in Europe and America.

Beginning with 161·5 tons in 1917–18, Madras Presidency alone imported about 31,575 tons of wattle bark valued at forty lakhs of rupees in 1939—50. For the 18 years from 1929—30 to 1946—47, Madras has been importing on an average 17,362 tons valued at 23·47 lakhs of rupees per year. The quantity imported by the other Provinces is not known but according to the Forest Research Institute leaflet No. 76 of 1945, 39,930 tons of wattle bark were imported into India in that year.

The tanning industry expanded considerably during the war, and it has been estimated that at present our minimum annual requirements of wattle bark are one to one and a half lakhs of tons. But for the fact that trade relations with South Africa have been broken off, we would have been importing this large quantity of bark at a cost of 375 lakhs of rupees. Following the breaking of trade relations with South Africa, the price of wattle bark has gone up abnormally, and towards the end of 1949, it rose upto Rs. 550/- per ton. But, even at this price, sufficient bark is not available and the tanning industry which earns a considerable amount of foreign exchange for the country, is put to very serious difficulties. It is therefore essential that adequate steps are taken to save the tanning industry by making India self sufficient in wattle bark.

WATTLE BARK OF COMMERCE

Under the trade name *wattle*, are included four different plant species: the black wattle *(Acacia mollissima)*, the green wattle *(Acacia decurrens)*, the silver wattle *(Acacia dealbata)* and the golden wattle *(Acacia pycnantha)*. Of the four, only the first two are important and yield the well known wattle bark of commerce. All the four species of wattle are indigenous to Australia, but it was in South Africa that its commercial importance was understood; and although large scale plantations were started only sixty years ago, today it covers an area of about one million acres of land and brings in a very considerable income to the country. The importance of wattle bark and its wide application in the tanning industry all over the world has encouraged other countries also to start large-scale plantations of wattle. According to a report in the journal of the American Leather Chemists Association, a scheme to plant up an area of 3,75,000 acres in ten years has been taken up in California since 1946 and it is proposed to extend this area to one million acres in twenty years. Among the Eastern nations, Indonesia has been a pioneer in the field and upto 1941, 25,000 acres have been planted up with wattle.

INTRODUCTION OF WATTLE INTO INDIA

Silver wattle, *(Acacia dealbata)* along with Eucalyptus was introduced into the Nilgiris between 1840 – '43 as a quick growing species to provide cheap firewood for the army stationed at Wellington. The species spread by means of root suckers and has now run wild over large areas in the Nilgiris. But due to the low tannin content of its bark — 9 to 12 per cent as against 35 to 38 per cent in *Acacia mollissima* – it serves only as a source of cheap fuel. By the middle of the last century, *Acacia mollissima* and a few years later *Acacia decurrens* were introduced into South India in the Prospect Estate at Naduvattam, in Kodaikanal (Upper Palnis), and the Kanan Devan Hills of Travancore as shade trees in tea estates. Although a small scale plantation was started in Kodaikanal as early as 1883, the importance of wattle as a valuable tanning material was realised only in the late thirties when the South African bark had gained great popularity and its demand was steadily increasing. Even then, no serious attempts were made either by the Government or the public to raise large-scale plantations; and inspite of the very great demand and attractive price, the total area under wattle in the Nilgiris at present is less than 2,000 acres with an annual production of 800 to 1,000 tons of bark.

SILVICULTURAL REQUIREMENTS

In Natal (South Africa), wattle grows at elevations varying from 100 to 3,500 feet above sea level although plantations are reported to be doing well even at 6,000 feet elevation where the frost and exposure are severe. In South India (latitude 8 to 11 degrees North), both *A. mollissima* and *A. decurrens* grow well above 5,000 feet elevation, the best growth being found between 6,000 and 7,000 feet. Above 7,500 feet, due to the incidence of heavy frosts and strong cold winds, the initial growth appears to be very slow, particularly so with *A. mollissima*. In such localities, wind belts of suitable species such as *Acacia melanoxylon* and *Eucalyptus globulus* can afford complete protection to the

wattle in its early stages. Experiments to grow the tree at lower elevations of 3,000 to 4,000 feet were started in 1947, but so far the results have been poor.

NURSERY TECHNIQUE

The wattle seed has very hard and tough testa and has to be pre-treated before sowing, if early germination is to be obtained. The pre-treatment of the seed is done thus: water, about five to seven times the volume of seeds is brought to boiling in a drum or pot and just when it has begun to boil, the fire from underneath is removed and the seeds are put into the water, stirring the whole thing thoroughly for some time. On no account should the water be boiled after the seeds have been put into it. The water with the seeds in it is then allowed to cool for 12 hours. The treated seed is afterwards washed five or six times in cold water to remove the gummy mucilage, and may be dried in shade (not in the sun) and stored in lead-lined boxes, if necessary. Treated seed has been found to retain its viability for six months to one year.

SOIL AND RAINFALL

Although wattle can grow on a wide variety of soils, however, for its proper growth and development, a loose, deep and well drained soil is necessary. Dark sandy loam or red loam (provided there is no hard laterite pan just below the surface), and a gentle slope appear to be the optimum requirements. In lateritic soils, the growth is fair. An impermeable clay pan or hard laterite close to the surface is most unsuitable and in such localities, the plants tend to become stunted and bushy. It wants a minimum rainfall of 35 to 40 inches per annum, preferably distributed over the greater part of the year. Damp, misty weather with a moderate rainfall not exceeding 55 inches encourages rapid growth and development. In regions of high rainfall (70 inches and above) and seasonal cold misty weather, the bark tends to become lichen-covered resulting in deterioration of the quality.

CHOICE OF SPECIES

Of the two species, *A. decurrens* is comparatively faster in its growth, particularly in the early stages and is more resistant to frost and the insect enemies "*frog hopper*" and the "*bag worm*", and produces straight, clean, knot-free timber which is in great demand for mine props and fence posts in South Africa. Besides, the tannin content of the bark is also slightly higher than in *A. mollissima.* For these reasons it gained very great popularity, and in several estates *A. mollissima* was replaced by *A. decurrens.* In South India also, till recently, *A. decurrens* was preferred and in most of the older plantations, there is a preponderence of this species. However, it was soon realised in South Africa that the bark extract of *A. decurrens* contained a significantly higher percentage of undesirable red and yellow colouring matter which imparted a poor colour to the leather and therefore fetched a much lower price. The South African estates realising the mistake are said to be rapidly changing over to *A. mollissima.* In South India also, the tanners prefer the bark of *A. mollissima* and this species is worthy of being chosen for future large scale plantations.

SOWING

The seeds are generally sown in the nurseries nine to twelve months prior to the date of planting. In South India, the planting season is June-July and the sowing is done early in September of the previous year. If instead of transplanting nursery-raised seedlings, direct sowing in the field is preferred, the treated seeds may be sown in the latter half of April and they will germinate with the first pre-monsoon showers. In the past, 2 to 2½ pounds of treated seeds used to be sown in a standard bed of 40 by 4 feet but subsequent experiments have shown that for uniform and proper development of the seedlings, the quantity sown per standard bed should not exceed one pound. With one pound of seed, a standard bed of 40 by 4 feet will give 3,500 to 4,000 seedlings. The seeds should be lightly covered with well decomposed humus and

watered daily from a fine rose can. Germination starts in about eight days and is complete in a month. The young seedlings are very much relished by rabbits, and rabbit-proof fencing is desirable till the seedlings reach a height of three to four inches. In frosty localities, particularly where early frost is common, adequate frost cover should be given to the nursery beds from the middle of October to the middle of February.

Some forest officers maintain the view that direct sowing of the seeds in the field is better than transplanting nursery raised seedlings. Direct sowing has certain advantages as well as disadvantages. Where labour is scarce and the area to be planted is large, transplanting may be very difficult and direct sowing preferable. As against this advantage, the disadvantages are many. In the first place, about 1 to 2 pounds of seeds are required for sowing one acre, while the same quantity will give 4,000 to 8,000 seedlings sufficient for 7 to 14 acres at an espacement of 9 by 9 feet or 10 to 20 acres at an espacement of 11 by 11 feet (the two espacements adopted in South India). Secondly, if the monsoon is late (as it has often happened), the seeds sown in April instead of germinating early in May will germinate only in June, and the seedlings standing close to each other and struggling for space will be hardly 3 to 4 inches high in the following November, and unless adequate frost cover is given, the casualties will be very heavy. Transplanting, on the other hand, though initially more expensive and requiring more labour, has definite advantages; and the several experiments conducted in the Nilgiris during the last ten years have shown that transplanting is significantly the better method of raising wattle. Six to nine inches high transplants, planted in late June or early in July, will under normal conditions grow to a height of 18 inches to 2 feet in the following November and unless the frost is exceptionally heavy, the casualties will be less than 10 percent and no frost cover is necessary. Nevertheless, in places where the incidence of frost is not heavy and labour is not available in large numbers, direct sowing is preferable.

PREPARATION OF LAND AND PLANTING

It is advisable to dig or plough the land two or three times before planting wattle, especially in grass lands, as the grass not only impoverishes the soil but seriously interferes with the early growth of the plant. In the Nilgiris, it has been found that planting wattle in association with a *Kumri* crop of potatoes is highly beneficial and encourages very rapid growth. This may be due to the fact that for potato planting, the grass and other weed growths are completely removed and the soil dug up to a depth of one foot. Experiments conducted for the last six years with or without kumri crops have shown that the early height growth of wattle is significantly better with kumri crops. But in steep slopes and in regions of high rainfall, the digging up of the soil or cultivation of crops like potatoes may result in heavy erosion and has therefore to be avoided. In the Nilgiris, however, no scraping is done and nursery raised transplants are planted in pits one foot cube. Manuring seems to be highly beneficial especially in grass lands. The results of nine experiments conducted in the Nilgiris show that manuring the pit with half a cigarette-tin of potato fertiliser (containing 12–14 per cent nitrogen, 8 per cent potash and 6–9 per cent phosphate) gives significant increase in height growth during the early stages. In South Africa, manuring with super-phosphate at the rate of 200–400 pounds per acre is commonly done and an increased yield of 15–40 per cent is obtained.

The best date of planting is between the second week of June and the second week of July depending upon the monsoon. The usual practice of planting blue gum (*Eucalyptus globulus*) in the Nilgiris is to pull out the seedlings from the nursery bed one month prior to planting out in the field, tie up the roots in a small bundle of moss with a little earth and keep the seedling under shade. The same procedure has been adopted in planting wattle also. It has been observed that if the unmossed seedlings are not planted at the proper time, the casualties may be heavy. Therefore, if the area for planting is large and labour is scarce, it is always better to use mossed transplants so as to limit the casualties to the minimum.

Experiments conducted in the Nilgiris since 1934 have shown that for the best growth and development of wattle, an espacement of 12 by 12 feet is necessary. As wattle is a shallow rooted species and liable to serious damage by wind, a wide initial espacement especially in exposed localities is not advisable. If a 12 by 12 feet espacement has to be adopted, adequate wind belts are necessary. During the first rotation, it is better to adopt a closer espacement of 9 by 9 feet and after suitable wind-belts have been established, the espacement may be increased to 12 by 12 feet during the second rotation.

AFTERCARE

The rate of growth of wattle is comparatively slow during the first year and at this stage, it cannot stand competition from weeds, particularly grass. In the Nilgiris, the common weeds found in the wattle plantations are *Hypericum mysorensis*, *Helichrysum Sp.*, *Dodonea viscosa*, *Eupatorium glandulosum*, *Eulex europeus* (gorse) and *Cytisus scoparius* (broom). Among the grasses, Kikyu *(Pennisetum clandestinum)* is the most harmful during the early stages. Regular weedings, two or three times a year preferably in September and December, after the South West and North East monsoons, with another weeding in April-May are necessary during the first year; and the operation may be continued in the second year also if sufficient funds are available. Weeding round young wattle seedlings must be carefully done to prevent root disturbance as far as possible. Although grown-up wattle can stand severe frost and cold winds, the plants are very badly damaged by ground frost till they reach a height of 2 to 3 feet. Frost cover during the first year should be provided at higher elevations, especially if direct sowing of the seeds in the field is adopted as the method of raising the species. Strict fire protection of the plantations during the first five years is necessary. Wattle is not browsed by domestic cattle but the damage caused by sambhur and wild sheep (The Nilgiri Ibex) is very great.

RATE OF GROWTH

While the rate of growth during the first year is comparatively slow, especially in plants raised by direct

sowing, thereafter, the height growth and diameter increment are both very rapid till about the fifth year and then fall off gradually. In the older plantations in the Nilgiris planted at an initial espacement of 6 by 6 feet and with no thinning done resulting in a dense stocking of 800-900 trees per acre, there was apparent growth stagnation by about the eighth year. In the subsequent plantations in which wider espacements of 9 by 9 feet and 12 by 12 feet were adopted, the trees continued to grow even after the tenth year. The rate of growth of wattle is more rapid in the Nilgiris than in Kodaikanal due to the better climatic and soil conditions. However, in certain isolated localities in Kodaikanal such as Berigam, the rate of growth is equal to, if not better than that in the Nilgiris.

THINNINGS

Wattle has strong affinity for light and cannot tolerate either overhead or lateral shade. In order to promote and encourage rapid growth, thinnings should be heavy and commenced early. In South India, so far no attempts have been made to thin wattle plantations and very little experimental data on the subject are available. Compared to the other aspects of wattle, little work has been done on thinnings and it is proposed to lay out experiments to determine the correct intensity and the periodicity of thinnings to be applied to the plantations in the Nilgiris. Generally speaking, a thinning appears to be necessary in the Nilgiris in the third year. However, as the initial espacement adopted in the Nilgiris is 11 by 11 feet, a thinning need not be done unless the growth warrants it.

ROTATION

The best rotation for wattle depends on the site quality and the treatment the plantation has received. In the past, South Africa had worked the plantations on 8 – 10 year rotation, but in recent years a rotation of 12 years was adopted in first and second quality sites and 8 to 10 years in poorer quality areas. The lengthening of the rotation from

10 to 12 years may be justifiable, if the trees are found to maintain the rate of growth even at the age of ten, but in regions where the rainfall is low and the soil conditions below average, it is more economical to fell the crop when it is eight to ten years old. No definite rotation has been fixed for the plantations in the Nilgiris, as reliable data on which it can be based are lacking. Tentatively, however, a rotation of ten years has been fixed irrespective of quality classes. As the average plantations in the Nilgiris appear to be between second and third qualities, a rotation of 10 years may be adopted. In old trees, 15 years and above, although the yield is more, the bark tends to become corky and its value as a tanning material is considerably reduced.

Experiments have been started in the Nilgiris to determine the best rotation for wattle. Four rotations, namely 7, 10, 13 and 16 years, are being tried and valuable data have already been collected. The indications are that in the Nilgiris, a seven year rotation is too short and a longer rotation of ten years will be more profitable. It is hoped that in about five years' time, sufficient experimental data will be available to fix the rotation for the large scale plantations started in 1950.

YIELD

The yield of bark varies from 3 to 12 tons per acre depending on the site quality and the thinning practice adopted. In South Africa, the yield varies from 8 to 12 tons per acre in the first quality areas and 4 to 8 tons in second and third quality sites. In the Nilgiris, the yield from the older plantations shows a wide variation from 3 to 7 tons per acre and this is to be expected as the initial espacement varied from 3 by 3 feet to 16 by 16 feet and no thinning was done. However, with the experience gained during the last fifteen years and the improved technique adopted in the later plantations, it can safely be assumed that an yield of 7 tons of bark will be obtained on a rotation of ten years.

The yield of fuel varies from 20 to 40 tons per acre in South Africa. Following the Craib's theory of thinning, the plantations in Natal have reported an increase of 30 – 40 per

cent in the yield of timber. In the Nilgiris, however, it varies from 15 to 30 tons. Considering the heavy stocking of 500 to 600 trees per acre maintained till maturity in the older plantations and the lack of proper tending and thinning, the above yield cannot be considered poor and on a very conservative estimate, an yield of 30 tons an acre in the Nilgiris will be obtained from the plantations raised since 1945.

STRIPPING OF BARK

The stripping of bark is a highly skilled operation. Before the tree is felled, a horizontal cut all round the tree about three to four feet from the ground is made and the bark is then stripped down as far as possible. This ensures the complete removal of the valuable bark on the stump. The tree is then felled by means of a cross cut saw and the bark is stripped upwards to the point at which immature bark is reached, generally upto one inch in diameter. In South Africa, the average out-turn per day for a stripper is about 800 pounds of bark, but it may vary from 400 pounds in a poor plantation to 1,000 pounds in a very good one. In the Nilgiris the out-turn of work is much less, an average worker being able to strip only 300 – 400 pounds per day.

DRYING AND PROCESSING THE BARK

The bark may be sold either green or dry. If factories for the manufacture of wattle extract are near at hand, it is better to sell the bark as green, because the loss in quality due to rain or mildew attack is avoided. For drying, the bark is usually spread out on brushwood or poles with the outer surface uppermost, so as to shed water. While drying, it is essential that no portion of the under-surface of the bark is exposed to the sun as such exposure produces a bad discolouration. It is dried thus till it becomes brittle and light brown in colour. Sun-drying the bark is the cheapest method, but during rainy season it may be dried in a specially constructed drier in which hot air from an oven is made to circulate between racks containing the bark. On no account should the green bark be heaped up or bundled

together because in such condition it is very easily attacked by mildew and its value goes down appreciably. As soon as the bark is stripped, it should be spread evenly either in the sun or during rainy season in a shed specially built for the purpose. The dried bark is chipped into lengths 6 to 9 inches, pressed into bales and sent to the tanneries or exporters. The bark from South Africa is received in Madras in pressed bales 2½ feet long, 1 foot 5 inches broad and 1 foot 2 inches high, each bale containing 200 pounds. This bark is imported in two varieties – chopped and crushed.

THE TANNIN CONTENT OF THE BARK

The following table shows the tannin content of the wattle bark grown in Australia, South Africa and India.

Place of origin		Percentage of tannin	Percentage of non-tannin
Species : Acacia decurrens			
Australia :			
St. Mary, New South Wales	..	42·10	8·03
Bataman's Bay	..	38 93	9·20
do.	..	36·75	7·94
South Africa :			
Warbury – Natal	..	35·87	7·44
Natal	..	35·72	10·45
do.	..	36·96	10·35
South India :			
Thayar Tea Estate	..	31·42	12·60
Prospect Tea Estate (Naduvattam)	..	35·60	11·71
Bouley Brothers, (Ooty) (Sillahalla Estate)	..	38·20	10·21
Tea Estates, Nilgiris	..	31·09	6·09
Species : Acacia mollissima			
South India :			
Parry's Estate	..	43 30	11·90
Thia Shola Estate	..	34·80	8·60
Baikie	..	28·50	5·00
Thayar Tea Estate	..	31·80	14·00
Sillahalla Estate	..	42·50	11·30
Travancore	..	39·80	8·90

From the above table, it is quite clear that the bark produced in South India is in no way inferior either to the South African or Australian bark. Comparative trials with

the indigenous and imported barks have only confirmed the above view. In 1939, the Leather Research Chemist, Madras analysed the leathers tanned with the Nilgiri and Durban barks and reported: "On the whole, there does not appear to be any difference between the two leathers. The bark can therefore be considered as efficient and fit for the South Indian tannage as the imported bark". Again in 1940, the Malang Trading Co., Madras, made a comparative trial with the Nilgiri bark and the imported bark and according to them, "the comparison will show that there is nothing wanting in the Nilgiri bark".

WATTLE EXTRACT

Chopped or compressed wattle bark gives tannin values ranging from 35 to 45 per cent whereas with extract the percentage of tannin can go upto 70 per cent or more. The wattle extract occupies only half the space of pressed bark. Wattle extract is therefore being used more and more in the wattle trade.

THE SUPERIORITY OF WATTLE BARK

Although wattle bark is rich in tannin, the amount of non-tannins is not proportionately high. In fact, with the single exception of Quebracho, the ratio of non-tannins to tannins is lower in wattle bark than in any other tanning material in the world. "The effect of this low percentage of non-tannins shows itself in two ways, on the barkometer strength and on the astringency." It has been found that wattle bark gives good weight to the leather and is excellent for the manufacture of heavy and harness leather. Very good leather can be produced from calf, sheep and goat skins from the bark liquors. "Its great value as a tanning material lies in its almost perfectly balanced tanning qualities which give a reasonably rapid penetration of the hide together with excellent weight in finished leather and a leather of good colour. A straight wattle tannage produces a mellow leather which is suitable for the currier and it can be converted into kit, bag, strap and harness leathers. The tensile strength and elasticity of wattle tanned leather is great."

SPENT WATTLE BARK AND ITS USES

The spent wattle bark, besides being a good fuel is a good raw material for the manufacture of paper. Experiments conducted at the Imperial Institute, London, showed that whilst a fairly useful paper could be produced with the bark alone, much better results may be obtained if it is used in conjunction with other paper making raw materials. In South Africa, a very useful straw board is being manufactured from 50 per cent each of spent bark and wattle wood; and wrapping paper from the bark alone.

WATTLE WOOD AND ITS USES

The timber after stripping the bark is mainly used as mine props, fence posts and fuel in South Africa. During recent years, it is being used more and more in the manufacture of wrapping paper and straw boards. Pulping tests carried out by the Drug and Oil Plant Project, U. S. A. have shown that the wood yields 52% of paper pulp by the soda or sulphate process, suitable after bleaching for book and fine printing paper. Pulping tests made by the semi-chemical process indicate that wall board made from wattle wood is inferior due to its short fibre, but paper boards made from the pulp have unusual corrugating properties. Similar tests carried out at the Forest Research Institute, Dehra Dun, with the wattle wood grown in the Nilgiris show that one ton of wood yields 17 cwts. of machanical pulp or 9 cwts. of chemical pulp, and both are short-fibred pulps. Howard Kegley, writing in the Journal of the American Leather Chemists' Association, (November, 1946) says: "A pulping mill, it has been learned, can operate profitably with wood sufficient to produce 100 tons of paper pulp per day. This means that atleast 1,500 acres of wattle trees must annually be made available to such a processing plant, that there must be a plantation of atleast 15,000 acres of wattle within the plants' district in order that 1,500 acres may annually be processed." The wood of black wattle (*Acacia mollissima)* has a high *alpha Cellulosa* content and has considerable potentialities as a raw material for the manufacture of rayons and plastics. In the Nilgiris, it is certainly possible to have

plantations extending over an area of 15,000 acres; and what is more, the district has two very great natural advantages, viz., cheap electric power and a plentiful supply of good clean water for starting a paper mill.

In the Nilgiris, the timber after stripping the bark is cut into three feet billets and sold as fuel. Although locally it is considered to be inferior to blue gum *(Eucalyptus globulus)*, it yields a very good charcoal and in this form it is becoming more and more popular. The following is an analysis of the results of destructive distillation of the sample of Nilgiri wattle.

Moisture	...	7·70	per cent.
Acetic acid	...	5·13	do.
Methyl alchol	...	1·21	do.
Tar (settled)	...	9·00	do.
Charcoal	...	29·50	do.

The results prove that from the point of view of yields, the Nilgiri wattle wood is one evidently suited for destructive distillation and compares favourably with ordinary European and American woods.

INSECT PESTS AND DISEASES

In the nursery, some damage is caused by cut worms and cockchafer larvae, but can be completely controlled by dusting with gammaxane and or 5 per cent. D. D. T. In the Prospect Estate at Naduvattam and Aramby shola in the Nilgiris, a myloceres beetle has been found to cause defoliation. During October – November, this insect feeds on *Acacia melanoxylon*. Dusting with gammaxane has been found to be effective. The cottony cushion scale *(Icerya purchasi)* has been found on wattle both in Kodaikanal and Nilgiris but the damage does not appear to be serious. As a result of the work done by the Madras Agricultural Department since 1943, this insect has more or less been completely controlled by the introduction of a lady-bird beetle, *Rodelia cardinalis*.

A jassid, commonly known as "frog hopper" (*Bythoscopus cadaranus*, Naude) and a capsid *(Lygidolon laevigatum, Reut)*

cause damage in wattle plantations. Due to these sucking insects, a kind of "Witches' brooms" is formed during mid-summer and autumn, and the height growth is reduced considerably. Froghopper is of widespread and almost annual occurrence. As it retards the closing of the canopy particularly during the first two years of the rotation, it leads to increased hoeing costs and lack of uniformity. Cut-worms *(Euxoa sagetis,* Schiff), cockchafer larvae *(Hypopholis sommeri,* Burm), *Adoratus capicola,* Burm, and white ants cause damage to the young seedlings, which sometimes may assume serious proportions. The Cerambicid beetle *(Pycnopsis brachyptera)* is becoming more wide spread. The practice of non-burning of the slash recently adopted may be the cause of this, for oviposition occurs only in dead, dying or decaying brushwood. The adult beetles feed on the bark and stems of new growth, especially in young plantations.

Eel worm *(Heteriodera marioni,* Cornu) occurs throughout the wattle growing areas. Its presence is easily seen by the appearance of a conspicuous swelling in the roots of the trees, particularly in young trees. The attack leads to a serious disturbance of the normal functioning of the roots and results in the permanent stunting, if not death, of the young trees. However, under favourable weather conditions and management, the trees are able to survive the attack of this nematode.

Gummosis or bleeding is "an obscure pathological condition of very wide occurrence". It is easily recognised by the free exudation of gum from the boles of trees and the black mottling of the bark. It is more commonly seen in older plantations, six years and above, and can be controlled to a large extent by sound silvicultural practices such as regular thinnings at the proper times. The bark of the affected trees, unless stripped immediately, becomes dry, brittle and useless.

AREA UNDER WATTLE IN SOUTH INDIA AND ITS FUTURE SCOPE

In the Nilgiris, there are one or two private estates where wattle is grown as the main commercial crop but in most of the estates, it is either grown as a shade tree for the tea bushes

or as a wind or fire belt and the exact area of the plantation is not available. Departmental plantations of wattle were started in the Nilgiris and the following table shows the area planted upto 1950 :—

Year	Departmental areas (acres)	Kumridars (Taungyadar) (acres)	Total acres
1939	30	—	30
1940	20	—	20
1941	50	—	50
1942	79	53	132
1943	55	40	95
1944	50	45	95
1945	50	60	110
1946	27	116	143
1947	5	152	157
1948	10	147	157
1949	15	109	124
1950	594*	50	644

* 555 acres planted in Mukurti area in 1950—'51.

In 1948, with the closing down of the Pyrethrum Division, an area of about 1200 acres formerly under pyrethrum was allotted for wattle and 706 acres have been planted upto end of March, 1951. In these areas, as the weed growth is comparatively less, wattle seems to grow very rapidly.

In Upper Palnis, out of a total area of 26,502 acres, 15,274 acres have been found to be suitable for wattle and have been included in the scheme drawn up by Sri V. S. Krishnaswamy, of the Indian Forest Service. In the Nilgiris, a total area of 10,818 acres of land is available for wattle planting and the scheme sanctioned in 1949 has taken over 6,000 acres for the present. In addition to this, the Wenlock Downs R. F. which is mostly grassland, situated between 6,000 and 7,500 feet and extending over an area of about 19,000 acres and serving as the catchment area of the Pykara, Moyar and Bhavani rivers is eminently suitable for wattle cultivation. But it is the policy of the Government to keep this unique beauty spot as a National Park. However, it is to be considered whether an area of 5,000 acres may be taken from the Wenlock Downs for wattle cultivation so as to have a plantation of 15,000 acres in the Nilgiris capable of supplying the necessary raw material for a paper mill.

PROBLEMS IN WATTLE PLANTING

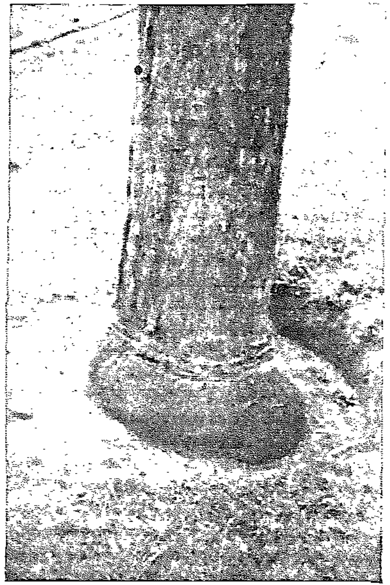
It has been mentioned earlier that the bark of *Acacia dealbata*, one of the four wattles, contains 8 – 12 per cent tannin and it serves only as a cheap source of firewood. In the Nilgiris, the species has run wild over large areas and is spreading rapidly by means of root suckers. *Acacia dealbata* flowers more or less at the same time as *Acacia mollissima* and there is every possibility of a hybrid having the poor tannin content of the former. South Africa has already taken steps to destroy all *Acacia dealbata* and this appears to be necessary in South India also.

During the last four years, it is observed in Nilgiris that the flowering season of the two main species of wattle, *Acacia mollissima* and *Acacia decurrens* overlap each other. Normally, the former flowers in January – February and very rarely in December, and the latter in October – December. The overlapping of the flowering seasons may be due to the abnormal changes in the seasons experienced since 1947. In any case, there is the possibility of a hybrid between *Acacia mollissima* and *Acacia decurrens*, and if we can evolve a strain of wattle having the hardihood of the latter without the undesirable qualities of its bark extract, it will indeed be a great achievement because *Acacia decurrens* is not only faster growing but more frost hardy than *Acacia mollissima* and the large amounts spent every year in providing frost cover could be saved.

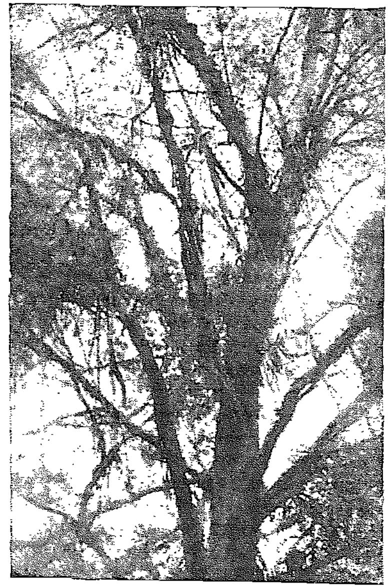
In South Africa, systematic and well planned research has been going on for the last ten years, to evolve a fast growing and vigorous strain of wattle with a high tannin content by careful seed selection. In the older South Indian plantations also, it is seen that certain trees show abnormal vigour of growth from the beginning till the end. As large scale plantations have now been started, it will be worth while to collect the seeds of such trees and then evolve a quick growing and high yielding strain of wattle.

THREE EUCALYPTUS SPECIES.

Eucalyptus amygdalina with its twisted like appearance of trunk.



Characteristic "bottle necked" base of trunk of *E. ficifolia*.



The bark of the branches peeling off and hanging freely — characteristic of *E. viminalis*.

5. EUCALYPTUS ON THE NILGIRIS
(WITH NOTES ON THIRTY-FOUR SPECIES)

The Nilgiri District has the pride of being the first place in the Indian sub-continent for the introduction of *Eucalyptus* species. This introduction dates back to 1843, when a few trees of eucalyptus were planted as an experimental measure in the search for some species which would yield regular and plentiful supplies of fuel. Fuel and timber were a problem at the time, since the indigenous supplies were not adequate to meet the demand for these essential materials which rose with the rapid growth of the Nilgiri District, particularly the parts around Ootacamund and Coonoor, which grew in fame as fine sanatoria. Regular plantations, mainly of *Eucalyptus globulus* popularly called the "blue gum", were started in the Nilgiris in 1856. By 1914, the total area of Government eucalyptus plantations, either pure or mixed with acacia had grown to 1089 acres and numerous privately owned plantations had also been established. In 1951, the area of State plantations was estimated to be 1776 acres.

The eucalypti in general are valuable in many ways. They are among the most important timber trees of the Australian Continent, where the *Eucalyptus* species form large tracts of forests. Some of the species grow into gigantic size and are among the largest trees in the world reaching more than 300 feet in height. They reach this size in one-tenth of the time taken by comparable species. For fuel production, the rapidity and volume of growth of many of the eucalypti in places congenial for their growth far exceed anything attainable by indigenous species. The Nilgiri District in particular has been fortunate in the establishment of blue gum trees, as not only they have helped the district to tide over critical periods of fuel famine but also normal supplies of fuel from these trees are so plentiful that they are ordinarily available at far cheaper rates than fuel in any other hill station in India. Some of the *Eucalyptus* species yield valuable oil, and the oil extracted from blue gum on the Nilgiris forms the source of a very good cottage industry in this district. In eucalyptus literature it is stated that one

58106

species, *E. amygdalina* yields as much as 3 percent of oil from its leaves. Kino and tannin are among other products of eucalyptus. Paper is another important product of this species and Edmundo Navarro de Andrade of Brazil* mentions that in S. Paulo, a paper mill has been working with cellulose or pulp from eucalyptus since March 1927, and has been manufacturing writing and printing paper using 25 to 30 percent of bleached pulp from eucalyptus as well as other kinds of paper using as much as 60 percent of eucalyptus cellulose. The bark of several species is used for roofing. Australia is supposed to owe its immunity from malaria to the eucalyptus family of trees. This direct anti-malarial effect of growing eucalyptus trees is well known. Some eucalypti stand any amount of moisture and are known to drain pestilential swamps. By some authorities, eucalyptus has been found to enrich the soil "with the falling of leaves, little branches and fruits with an average weight of 12,500 pounds per acre per year".* Fence posts, piles for foundations, poles for telephone, telegraph and electric service are among the other uses of the wood of eucalyptus. As high class timber, however, the eucalypti have not been consistently good. Because of the special structure of the wood, trees of many species, less than thirty years of age and of diameter less than three feet, split when sawed, and the ties have a tendency to crack at the ends, a defect which is common to a great number of hardwoods. In fact, in the Nilgiris, the blue gum which is the only eucalypt of importance has indifferent reputation as timber but the wood is fairly durable and is used for fence posts. It is the principal source of fuel supply in the Nilgiris and owing to its rapid growth and high yield, it is eminently suitable for cultivation as a fuel tree. The oil from the blue gum however, as already stated, is an industrial byproduct of the eucalyptus plantations.

Eucalyptus globulus, LABILL. BLUE GUM

Since the blue gum (*E. globulus*) is of the utmost importance to the Nilgiris, a brief description is given below of the tree and the method of raising a blue gum plantation.

*Edmundo Navarro de Andrade: *The Eucalyptus in Brazil*, *Jour. Heredity.*, 32: 215—20, 240. 1941.

Eucalyptus globulus is a very large tree with a tall straight clean bole when grown under forest conditions but has a tendency to branch freely when grown in the open. The trunk has smooth bluish white bark which peels off heavily, exposing the smooth bluish white stem. Older leaves are lanceolar, comparatively longer, with tendency to be sickle-shaped, long, green and thick with copious oil dots. Juvenile leaves are cordate, sessile, opposite, covered with a bluish white bloom and strongly impregnated with a gummy aromatic oil, on quadrangular stem. The flowers are always borne solitary unlike in many of the Eucalyptus species. The calyx is united into an octagonal tube. Stamens are numerous and white. Fruits are broadly conical with angular ridges and broad borders. On the Nilgiris it surpasses all other species in the rapidity of growth and early yield of fuel. It is used in California for insulator pins, spokes, felloes, whiffle trees, handles, flooring and interior finish, and fuel. The logs check badly in curing.

The blue gum requires moist equable climate, a deep fertile soil and endures excessive moisture but not swampy ground. It is unsuitable for plains or any elevation below 4,000 feet. While at other hill stations, blue gum has been grown, it is in the Nilgiris however that it grows to the highest satisfaction. It is planted at elevations between 5,000 and 8,300 feet. Besides the climate, the red clayey soil overlying gneissic rock, and largely free from lime appears specially favourable to the growth of the tree. The *shola* lands have proved superior to grass lands for the blue gum.

Sowing: The best time for sowing the seeds is from January to March, enabling the seedlings to reach an adequate size for planting out at the beginning of the rainy season. The cheap method of raising seedlings is in raised seed-beds, consisting of a mixture of fine leaf mould and sand. The seeds are sown broadcast on the surface and lightly covered with a layer of fine earth. The seedbeds are kept moist with fine spray of water until germination begins. From the beginning of sowings, the seed-beds are protected by a thatched cover about twelve inches above them, to protect the seed-beds from sun, frost or heavy rain. Watering is

done to the beds fairly frequently but sparingly with a fine spray, since excess water may cause damping off of seedlings. When the seedlings attain a height of 2 to 4 inches, they are pricked out to 2 to 3 inches apart in nursery beds and shaded for the first two or three days. On attaining a height of about 6 inches, a method of "mossing" is adopted, in which the roots of the seedlings are enclosed in a ball of earth and wrapped round with moss to facilitate retention of moisture. The mossed plants are placed in the ground under partial shade, regularly watered and shifted slightly every few days, to prevent the roots from fixing themselves in the ground.

Planting: The seedings are planted when they are about 12 inches in height. The best time for planting is about the beginning of the rainy season. It is preferable that the pits are dug two or three months prior to planting and the soil exposed. The question of spacing has been somewhat controversial, but with the experience on Nilgiris, a spacing of 9 feet by 9 feet seems to have done better than any closer spacing.

After Care: For the first one or two years, it may be necessary to protect the young plants from frost by means of cowls of grass or bracken. Hand-watering is not ordinarily practicable on a large scale, but the seedlings are known to respond well to irrigation, if ever it is possible. From about the sixth year to the tenth year, thinnings become necessary and on this depends the subsequent development of the crop and the yield. The system of working adopted for the blue gum on the Nilgiris is mostly simple coppice for the production of fuel, the rotation adopted originally being ten years, then later raised to fifteen years, and in recent years to twenty years. The coppicing power of the tree is remarkable, numerous shoots being sent up both from the cambium round the top of the stool, and from the periphery of the stool lower down, but chiefly from the latter. A callus forms over the top of the stool and may cover it completely in a few years. If a species is to be useful as a fuel tree, it should coppice readily and in this respect, the blue gum is one of the most suitable. The best method of re-generation is said to be clear felling and re-planting.

OTHER EUCALYPTUS SPECIES ON THE NILGIRIS

The genus Eucalyptus is said to consist of more than 140 different species, all of Australian origin. Of these, the layman in India is generally aware of only the blue gum *Eucalyptus globulus*, which has been dealt with above in some detail as a source of fuel for the Nilgiris and as a source of eucalyptus oil of commerce, for which Nilgiris is the chief centre of production in this country. But ever since the introduction of *E. globulus* on the Nilgiris in 1843, several other species have been tried on the Nilgiris and adult trees of thirty-three species excluding *E. globulus*, many of over sixty years in age are now in existence in the Botanic Gardens and Sim's Park, Coonoor, most of them on the latter. The notes given below are the result of a first hand study of these species in the Government Gardens and Parks. Except one or two of the species, none of the rest have been properly evaluated in respect of their utility, for further exploitation on the hill ranges industrially or in other ways economically. The following notes on the thirty-three species established in the Government Gardens and Parks of the Nilgiris are intended to create further interest in their existence on the hills leading towards an exhaustive study of the species and their better utilisation. Description of size of trees refers to the specimens observed at the Government Gardens and Parks, Nilgiris. The notes on each species deal with the size of tree, brief description of tree and its economic value.

(1) *E. albens*, Miq. WHITE BOX.

It grows to a height of 70 feet with a thickness of trunk of one and a quarter feet.

It has dark brown, deeply wrinkled or fissured persistent bark. The leaves are pale green on both sides, linear, thick, with spreading veins. Flowers are on compressed stalks in umbels of 3 to 5 flowers with calyx united into a cup, and with numerous, whitish stamens. Fruits are angular with deeply inserted valves.

The wood is pale brownish, very strong, durable and economically valuable.

(2) *E. amygdalina*, Labill. PEPPERMINT GUM. ASH MOUNTAIN TREE. GIANT EUCALYPTUS. WANGARA.

It grows very tall. At Coonoor, it attains a height of 150 feet and a thickness of trunk of nearly five feet. It is at its best considered among the tallest trees of the world said to be over 400 feet in some places. Its only rival in height among eucalypti is supposed to be the *Karri* of

West Australia, *E. diversicolor*. It is said to be the best of all for malarial regions and unsurpassed for quantity of oil from leaves.

It has bluish white bark which is highly peelable exposing the twisted like appearance of whitish trunk by which this species can easily be identified. Leaves are lanceolar and extremely narrow, slightly curved and oblique, deep green with prominent oil glands, with veins not being very marked. Flowers are borne on umbels of 6 to 10 flowers, with pale green, narrow calyx united into a cup, and with numerous creamy white stamens. Fruits are small, semi-ovate and in clusters.

Leaves are produced heavily and yield an oil which is mildly pleasant in flavour resembling peppermint. The tree is considered highly ornamental because of its twisted-like whitish stem and branches. Good specimens of this species are seen in Sim's Park, Coonoor.

The timber floats in water, unlike most eucalyptus, and is good for shingles, palings and rails, but not very lasting underground and not a superior fuel.

(3) *E. botryoides*, Smith. BASTARD MAHAGONY.

It grows to a height of 75 feet with thickness of trunk of three and a half feet, with spreading large branches. It is a handsome tree.

It has dark brown persistent bark which is furrowed into numerous patches, and light brown wood. Leaves are broadly lanceolar, dark green above and paler beneath with very distinctly marked veins. Flowers are in umbels of 6 to 10, with numerous creamy white stamens. Fruits are semi-ellipsoid with depressed borders.

It grows very well at Coonoor and is good for wind breaks and shade. The timber elsewhere is utilised in the manufacture of wagons, trucks and heavier kinds of wheel wrights.

(4) *E. Caesia.*

It is a tall tree growing to a height of about 100 feet with thickness of trunk of 2 to 2½ feet and branches spreading to 35 feet all round.

It has blackish grey bark which splits into many narrow angular pieces, which remain persistent. Leaves are broadly lanceolar, dull green, very thick, with scanty oil dots. Flowers are in umbels of usually 3 to 5, with cup-shaped calyx and numerous white and incurved stamens. The fruits are bell shaped.

The timber is hardy and good for telegraph posts.

(5) *E. camphora*

The specimens at Coonoor are small trees growing to a height of about 30 feet with thickness of trunk of hardly six inches.

The bark is dark brown leaving a smooth ashy white stem. The leaves are broadly lanceolar, dark green, with indistinct veins and prominent oil glands, readily yielding a fragrant smelling oil. Juvenile leaves are rather oblong, sessile, with ashy white and powdery coating. Flowers are borne on umbels of 3 to 5 small flowers, with calyx united into a narrow tube and having dull white stamens. Fruits are ovate truncate.

Oil has a very pleasant flavour. Wood is known to be very useful as pillars in Australia.

(6) *E. citriodora*, Hook. (*E. maculata* Var. Citriodora, Bailey). LEMON-SCENTED GUM.

The tree is ornamental in appearance and grows to a height of 100 feet with characteristically beautiful pendulous branches and brown bark which completely peels off, leaving the smooth ashy white wood. The trunk attains a thickness of three feet. Leaves are narrowly lanceolar and curved like a sickle, dark green above and paler beneath, with prominent oil dots and indistinct veins. Flowers are always borne on panicles of 6 to 10 flowers, with individual flowers having long pedicels, bright green calyx united into a narrow cup and numerous white stamens. Fruits are semi-ovate with depressed borders.

The leaves yield a lemon-scented oil, useful as a base for perfumes. The oil is clear, white and of a pleasing, penetrating odour.

The species is well worth attention for expansion on a commercial scale. It has proved itself suitable for the Mysore plateau as well as Wynad area.

(7) *E. crebra*, F. v. M. NARROW-LEAVED IRON BARK. GREY GUM.

It grows to a height of 80 feet, with a trunk thickness of 1½ to 2 feet and a spread of 25 feet.

The bark is dark brown, persistent and deeply ridged and furrowed. Leaves are narrowly lanceolar, with indistinct veins and not very prominent oil glands. Flowers are in umbels of 3 to 5, on elongated stalk and have green calyx united into a very small cup with numerous creamy white stamens. Fruits are very small, ovate-truncate, with depressed borders.

The growth of young trees is very slow and not very successful on the Nilgiris.

The tree is valued elsewhere for its reddish, hard durable wood which is used very much for building of wagons, bridges and posts.

(8) *E. deanii*.

It is a very robust tree growing to a height of 90 feet, with trunk thickness of 4 to 4½ feet and a spread of 50 feet.

The bark is dark brown and splits into many pieces which remain persistent on the trunk region but peel off on branches, exposing the bluish white wood. Leaves are broadly lanceolar, dull green, thick, with indistinct veins and not very prominent oil glands. Flowers are in umbels of 5 to 7 on short stalks, with numerous dull white stamens. Fruits are semi-ovate and very small.

Timber can be utilised as building material.

(9) *E. dives*.

The tree grows to a height of 90 feet, with trunk of 2½ feet thickness and a branch-spread of 20 feet.

The bark is brown and stringy, has tendency to split and is semi-persistent on the stem, which is dull grey in colour. Leaves are broad, lanceolar, slightly curved, dark green above and pale beneath with indistinct scattered oil dots. Flowers are in axillary umbels, of 3 to 7, with calyx united into a linear cup and numerous whitish stamens. Fruits are medium in size, truncate ovate, with flat rim.

The timber is said to be ordinarily of little value.

(10) *E. eugenoides*, Sieb. RED GUM. STRINGY BARK.

It grows very tall to a height of nearly 120 feet, with trunk thickness of 3½ feet to 4 feet. It is said that the tree is capable of growing to a size in the Nilgiris, not attained in its natural home.

The bark is dark red and stringy, peeling off in patches but remaining attached to the stem. Leaves are very shiny, lanceolar, slightly oblique, with oil dots not very prominent. Flowers are in axillary umbels consisting of 3 to 5 flowers, with calyx united into a broad cup. Stamens are white, numerous and incurved. Fruits are semi-globular.

(11) *E. ficifolia*, F. v. M. CRIMSON FLOWERED EUCALYPT. RED FLOWERING GUM.

It is a handsome, medium tree growing to a height of 40 feet with trunk diameter of 2 to 2½ feet.

The bark is pale brown and persistent on the stem. The trunk is "bottle-necked" above the ground, which is found to be very characteristic of this species. Leaves are dark green, very broad, with elongated tip, and not very prominent vein, and leathery in texture. Flowers are borne on panicles of 5 to 7 flowers on long stalks, with green calyx united into tube, carrying numerous, out-curved, bright red stamens giving a brilliant red appearance to the flowers and the name "Red Flowering Gum". Fruits are urn shaped and borne in paniculate clusters.

This tree is one of the most splendid acquisitions to ornamental horticulture on the Nilgiris and when in flower between May and August is one of the most gorgeous on the scenery of the Nilgiris, with brilliant trusses of flowers diffusing a rich red colour over the dark green foliage of the tree. The flowers are however known to vary from pink to crimson and scarlet but these forms are not found to come true to seed. Grafted plants to reproduce these forms are said to be offered in the trade in the advanced eucalyptus countries.

As one of the exceptions among eucalypti, it does not yield any oil.

(12) *E. Gunnii*, Hook. SWAMP GUM TREE. CIDER GUM.

It is a small sized tree with trunk thickness of about a foot. The bark is black and stringy, and persistent except on the ends of branches. Leaves are broadly lanceolar, dark green on both sides, with prominent veins, distinct submarginal venation and rather sparse oil dots. Flowers are borne in umbels consisting of 4 to 6 flowers. The calyx is united into a broad cup, and the stamens are numerous and dull white. Fruits are small, truncate with depressed valves, opening out in a slit.

The leaves do not have the strong aromatic odour characteristic of most eucalypti and are known to be readily browsed by cattle and sheep. The wood is very hard and splits with difficulty.

(13) *E. hemiphloia*, F. v. M.

It is a evry tall tree growing to a height of 120 feet, with trunk thickness of 4 to 4½ feet.

The bark is dark grey in colour and persistent on the trunk but stripping off from branches in flakes or long strips. Leaves are ovate lanceolate, moderately curved, with indistinct veins and concealed oil dots. Flowers are in paniculate clusters of 4 to 10 flowers, with calyx

united into an angular tube with numerous, dull white stamens. Fruits are hemi-ellipsoid with compressed borders.

The tree can be useful as a shade tree because of its dense foliage and is also useful for fuel. The timber is pale, strong, hard, and furnishes material for lasting fence posts and various building purposes. The tree is also known to be good as pasturage for bees.

(14) *E. leucoxylon*, F. v. M. (*E. gracilipes*, Naudin). WHITE IRON BARK.

The specimens at Coonoor are not very good and are very slender trees.

The bark is dark brown which peels off very indistinctly. Older leaves are lanceolar, dark green and thick textured, while juvenile leaves are obconical with indistinct veins. Flowers are borne in axillary clusters of 4 to 6 flowers, with green tubular calyx, and numerous rosy pink stamens. Fruits are semi-ovate.

Timber is hard, durable and suitable for shafts for wheel works, railway sleepers and for underground work. The tree is known to be good pasturage for honey bees, and excellent honey is said to be obtained from this species. Good specimens are likely to form handsome avenue.

(15) *E, Longifolia*, Link & Otto. WOLLY BUTT.

It grows to a height of about 120 feet but with a fairly slender trunk of 2 to 2½ feet thickness.

The bark is grey, fibrous and persistent. Leaves are elongate, lanceolar, moderately sickle shaped, with distinct veins and conspicuous oil dots. Flowers are in clusters of 3 to 4, on long stalks which are quadrangular. The calyx is united into a smooth tube and the stamens are numerous and dull white. Fruits are rather large and bell shaped.

The bark is known to be useful as packing material because of its fibrous texture. Timber is very strong and used for building purposes in Australia. On the Nilgiris, timber can be used. The flowers are produced continuously and are valuable for honey bees.

(16) *E. macrandra.*

It is a medium tree growing to a height of 50 feet with trunk thickness of 1½ to 2 feet and branches well spread.

The bark is dark brown and persistent on the main stem but peels off in shreds on the branches. Leaves are light green in colour, narrowly lanceolar with numerous oil-dots and indistinct veins. Flowers are in umbels of 3 to 5, with calyx united into a cup and numerous whitish stamens. Fruits are semi-ovate.

Leaves yield oil with an agreeable odour. The wood is hard, mostly tinged with reddish brown colour but durable.

(17) *E. macrocornys.*

This grows to a height of 120 feet, with trunk thickness of 5 feet and profuse, thick branches, spreading over 60 feet.

The bark is dark grey, stringy and persistent. Leaves are lanceolar, sickle shaped with much concealed oil dots. Flowers are borne on umbels of 6 to 10, with calyx united into a tube and numerous creamy whitish stamens. Fruit is hemispherical to semi ovate, with valves which project out as conical teeth.

The thick stringy bark can be used for roofing and the hard durable wood for buildings and cabinet making.

(18) *E. maculata*, Hook. SPOTTED GUM.

It grows into a very tall handsome tree of 125 feet height, with trunk thickness of 2 to 2½ feet.

The bark is smooth and brown, and completely peels off in patches, leaving smooth brownish white wood inside, with spotted appearance. Leaves are elongate, lanceolar, with indistinct veins and oil dots. Flowers are in short axillary panicles of 2 to 3 usually, with calyx united into a bell shaped cup and numerous creamy white stamens. Fruits are small, and urn shaped.

The leaves yield oil with agreeable smell. Timber is known to be valuable for ship builders, and coach factories. Wood is strong, elastic and durable and easily split.

(19) *E. marginata*, Smith. (*E. floribunda*, Hueg.) JARRAH.

It is a tall tree growing to a height of 85 feet, with trunk girth of 1½ to 2 feet and a branch spread of 30 feet.

The bark is brown and peels broadly. Leaves are lanceolate, curved, with very prominent oil dots. Flowers are borne in umbellate clusters of 3 to 5, on long stalks. Calyx is green and cup-shaped and the stamens are numerous and white in colour. Fruits are more or less globular in shape.

Wood is very tough and even grained, and can be used for making small boats and for building purposes. Timber is known to be easily worked, takes a fine polish and is almost incombustible. It is used in England for street paving and in Australia for piles, underground work, telegraph posts, ties, flooring, shingles, and general construction. The timber is said to last for a long time under various conditions, above ground, under ground or under water. It is so valuable that Western Australia alone is supposed to have eight million acres under this species. Further trials on the Nilgiris with this species are very much recommended.

(20) *E. melliodora*, Cunn. YELLOW BOX TREE. HONEY SCENTED GUM.

It is a medium sized tree growing to a height of 40 feet, trunk thickness of 1½ feet, and branch spread of 25 feet.

The bark is brownish grey outside and yellowish inside, fibrous, and more or less persistent on the stem. Leaves are narrow, lanceolar, dull green, with indistinct veins and copious oil dots. Flowers are in axillary umbels of 4 to 7. Calyx is united into a tube which is hemispherical to semi-ovate. Stamens are pale white and numerous. Fruit is truncate, hemispherical to semi-ovate with broad borders.

Wood is yellowish and when dry extremely hard. It can be utilised for spokes, rollers, heavy frame work. It is known to be excellent fuel. Flowers are full of nectar and attracted by bees.

(21) *E. pilularis*, Smith. BLACKBUTT.

The specimens at Sim's Park, Coonoor are tall trees growing to a height of 100 feet, with trunk thickness of 3 feet, and with angular branches.

The bark is rough and fibrous, blackish grey outside and brownish red inside and persistent in the lower portion of the tree. Leaves are sickle shaped, and rather shiny. Oil dots are completely absent and this tree is

a *non-oil-yielder*. Flowers are in umbels of 5 to 7, with calyx united into a semi-globular cup. Stamens are numerous and all influxed. Fruit is truncate-ovate with depressed valves.

This species comes up very well under Coonoor and Ootacamund conditions. Timber is excellent for general purposes and particularly valuable as telegraph posts, railway sleepers, and flooring boards. It is known also to be a good honey producer.

(22) *E. piperita*, Smith. SYDNEY PEPPERMINT. PEPPERMINT GUM.

It grows to a height of 60 feet, with trunk thickness of 2½ feet. The bark is dark brown, splitting into many longitudinal pieces, which remain persistent on the stem. Leaves are lanceolar, curved, shiny green, with copious oil dots. Umbels are lateral consisting of upto 10 flowers. Calyx is united into a cup, and stamens are white and numerous. Fruits are small, truncate or globular ovate.

The oil is sweet scented and the wood is useful for telegraph posts because of its hardy nature.

(23) *E. punctata*, D. C. HICKORY EUCALYPT. LEATHER JACKET. HICKORY GUM.

It grows to a height of 85 feet, with trunk thickness of 2½ feet and a spread of 40 feet.

The bark is dark brown, splitting into long flakes. Leaves are lanceolar with many veins and marked oil dots. Flowers are in umbellate clusters of 3 to 5, small, with green cup-shaped calyx and numerous whitish stamens. Fruits are semi ovate, with depressed borders.

The timber is remarkable for its extreme hardness and durability. The wood is very useful for railway sleepers.

(24) *E. redunca*, Schau. WANDOO. WHITE GUM.

It grows tall to a height of 100 feet, with trunk thickness of 2½ feet and branches spreading well to 60 feet.

The bark is smooth and whitish. Leaves are linearly lanceolar, dull green, with indistinct veins and much concealed oil dots. Flowers are in axillary umbels consisting of 5 to 10 flowers on compressed stalks. Calyx is united into a semi-ovate tube and stamens are numerous and whitish. Fruits are semi-elliptical with narrow valves.

Wood is pale brown, hard, tough and heavy, and can be utilised for building purposes and for shafts, and spokes of wheels.

(25) *E. regnans*, F. v. M. (*E. amygdalina*, Labill. Var. regnans, F. v. M). GIANT GUM.

The tree grows to a height of 90 feet as seen at Coonoor but in a suitable habitat, it is said to attain a height of 325 feet.

The bark is greyish and peels off in characteristic linear strips. Leaves are broadly lanceolar, curved, with very prominent oil dots. Flowers are in umbels of 6 to 10 flowers, with pale green, narrow calyx united into a cup and with white stamens. Fruits are semi-ovate in shape.

Leaves yield an agreeable oil. Timber is valuable.

(26) *E. resinifera*, Smith. KINO EUCALYPT. RED MAHAGONY.

It grows to a height of 80 feet, with trunk thickness of 2½ feet and well spreading branches.

The bark is dark brown, fibrous, and persistent on the trunk but deciduous on the branches. Leaves are lanceolar with characteristic submarginal venation, green above and pale green beneath. Flowers are on umbels of 5 to 7, calyx united into a pale green, almost conical tube and stamens numerous and white. Fruit is bell shaped, and borne on clusters.

The bark yields a resinous stuff known as "kino" which is said to be used in medicine against diarrhoea. The oil is very pleasant and seems to merit attention as a disinfectant for sanitary purposes. Timber is known to last well underground and not liable to shrink.

(27) *E. robusta*, Smith. SWAMP MAHOGANY.

It is a tall tree growing to a height of 100 feet, with trunk thickness of 2½ feet.

The bark is greyish, stringy and persistent. Leaves are fairly large, broadly lanceolar, and very thick. Flowers are in umbels of 5 to 7 flowers, with light green calyx, united into a bell shaped tube, and numerous, whitish stamens. Fruits are truncate ovate with depressed rims.

Wood is very hard, fine grained and said to be valuable for furniture purposes, sleepers, posts, joists, and fuel.

(28) *E. rostrata*, Schlect. RED GUM.

The specimens seen at Coonoor are of medium size growing to a height of 35 to 40 feet, with trunk thickness of 2½ feet. It is said that under proper environment, it is capable of a height of 200 feet.

The bark is dark brown and peels off in long shreds leaving a smooth brick-red wood. Leaves are sickle shaped, dull green, with not very prominent oil dots. Flowers are in umbels of 3 to 5 flowers, with calyx green and united into a tube and stamens numerous and pinkish in colour. Fruits are semi-globular with dentate projecting valves.

Timber is very durable both above and below ground, and is said to resist insects and wet tropical heat. It can be used with profit for fence posts and rail-road ties. It is not good for furniture purposes and difficult to work when dry. The tree is good pasturage for bees.

(29) *E. saligna*, Smith. WHITE GREY. GREY GUM.

One of the specimens at Sim's Park, Coonoor is among the largest seen at the Park, growing to a height of more than 150 feet, with profuse branches spreading over 60 feet and a straight trunk with thickness of 3½ to 4 feet.

The bark is smooth and grey, peeling off in layers. Leaves are lanceolar, elongated, with numerous lateral veins. Flowers are borne in paniculate clusters of 3 to 8 flowers, with a thick clayx united into a bell-shaped cup and numerous, creamy white and slightly scented stamens. Fruits are small, bell-shaped and borne in clusters.

Wood is hardy, durable and valuable for ship building.

(30) *E. staigriana.*

The specimen at Coonoor is a very slender tree, with trunk thickness of only about six inches.

The bark is brownish, wrinkled and persistent on the stem. Leaves are sickle-shaped, shiny on the upper surface, and dark green below, with not prominent oil dots. Juvenile leaves are obconical, opposite and sessile. Flowers are in clusters of 2 to 3, with green calyx and numerous, whitish stamens. Fruits are small, topshaped with broad rims.

Wood can be used as fuel and for fencing purposes.

(31) *E. smithii.*

It grows tall to a height of 120 feet, with trunk diameter of 2½ feet.

The bark is dark grey outside and pale brown inside, completely peeling off leaving a smooth, pale brown wood. Leaves are narrowly lanceolar, pale green, with indistinct veins and not very prominent oil dots. Flowers are in umbels of 3 to 5 flowers, with calyx united into a tube, and numerous, pinkish white stamens. Fruits are truncate with projecting conical slits.

Timber is hard, durable and of multipurpose value.

(32) *E. tereticornis,* Smith. BASTARD BOX. FOREST GREY GUM. FLOODED GUM.

It is a tall tree, growing to a height of 100 feet with trunk thickness of 3 feet.

It has dark brown bark, which peels off and sheds leaving ashy white stem with a slightly twisted appearance. Leaves are broadly lanceolar, deep green with sub-marginal venation and very distinct veins and not very prominent oil-dots. Flowers are in umbels of 5 to 6 flowers, with calyx green and united into a bell shaped cup, and stamens numerous, whitish and curved inwards. Fruits are small, semi ovate, dehiscing in conical slits at the top.

Timber is pronounced excellent and can be used for railway and naval equipments and building purposes.

(33) *E. viminalis,* Labill. MANNA EUCALYPT. MANNA GUM.

It is a tall tree growing to a height of more than 100 feet, with a stem diameter of 4½ feet and widely spreading branches. It is ranked by many as only next to *E. globulus* in rapidity of growth. In Eucalyptus literature, it is mentioned as capable of attaining a height of 300 feet and stem diameter of 17 feet.

The bark is dark brown, rough, wrinkled, partly persistent on the lower part of the stem but peeling off on branches in long strands, hanging loosely, thus giving a characteristic, somewhat ornamental appearance to the tree. Leaves are short, lanceolar, dark green, with very indistinct veins and inconspicuous oil dots. A sugary substance 'manna' is exuded by the leaves from March to June, which is rich in saccharine and tastes very sweet. Flowers are borne on umbels of 5 to 7 flowers with calyx united into a cup and numerous, whitish stamens. Fruits are truncate in shape, covered with a lid and dehisce transversely.

The oil yielded by the leaves is very heavy and dense. The timber is very strong but can however be used for rails and shingles. It is inferior for fuel. It is a good bee tree.

TRIALS OF EUCALYPTUS SPECIES BY THE FOREST DEPARTMENT

According to the Provincial Silviculturist, Ootacamund, the species originally tried by the Forest Department, were *acmenioides*, *ciderofolia*, *crebra*, *eugenioides*, *globulus*, *hemiphloia*, *paniculata*, *pilularis*, *propinqua*, and *punctata*. Of these, *globulus*, *eugenioides* and *paniculata* fared best. The results with the hardwood species such as *pilularis*, *propinqua*, *acmenioides* and *crebra* were not satisfactory and further trials with these were stopped.

Since 1947—'48, *marginata*, *dives*, *albens*, *maculata* and *astringens* were also tried. The Provincial Silviculturist considers *marginata* and *astringens* as very promising. The bark of *astringens* is found to contain more than 40 percent tannin and the work is in the direction of finding an eucalypt which will do the work of wattle and blue gum, by giving tan bark and firewood at the same time. In 1950, five acres of further experimental area of these two species have been planted by the Madras Forest Department.

SUMMARY AND CONCLUSION

It has been brought out in this article how the Nilgiris has been the first district in India to pioneer in the introduction and establishment of eucalyptus species and how certain of the species have become economically very important to this district and how Nilgiri District holds almost a monopoly in the supply of eucalyptus oil. Attention has also been focussed to the fact that while numerous species of eucalyptus were introduced and successfully established, systematic study of these species has not been attempted nor a satisfactory study of their full utility. A beginning has been made in this article in briefly describing the performance, identifiable characters and possible uses of 34 species of Eucalyptus including *E. globulus*. A brief account of the work done by the Forest Department has been included. It

is hoped that with the co-operation of the Agricultural Department and the Forest Department, further work on the valuable species of eucalyptus will be intensified and plantations in worthwhile species will be expanded on the slopes of the Nilgiris which today tend to be barren and demand trees to cover them to stop the downward march of soil by erosion.

Besides further introductions of new species from an unequalled wealth of species fortunately available in eucalyptus, hybridization in eucalyptus is also possible, as pointed out by Edmundo Navarro de Andrade of Brazil,* who is quoted below:

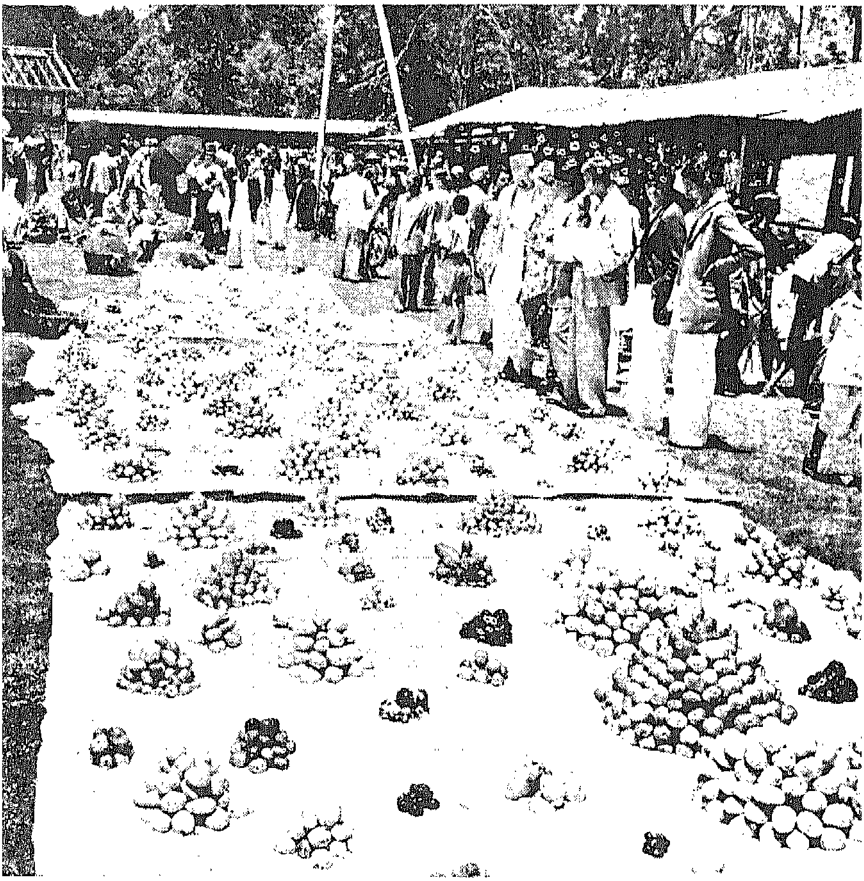
"For a long time, Baron Ferd von Mueller, first Director of the Botanical Garden of Sydney, Australia and the author of the monumental "Eucalyptographia", thought it was impossible to hybridise eucalyptus, as the flowers are protected by the operculum until after they are fertilized. This was a mistake. Professor L. Trabut, Director of Agriculture in Algeria, French Africa has obtained different hybrids now known as *E. trabuti*, *E. algeriensis*, *E. antipolytensis*, and *E. oranensis*. In my experiments in Brazil, I have also many hybrids, with two or three very remarkable. One of them, the best one, is *E. paulistana*, obtained by natural breeding between *E. globulus* and *E. robusta*. Very interesting is the fact that its parents are not good species for Brazil, while the hybrid is a very fine tree with all the virtues of its parents, but without their defects. The *E. paulistana* has the rapid growth of globulus and is much taller than robusta.

"Since such a large number of species of eucalyptus exist in nature, it has been simpler to find the species, best adopted to Brazilian conditions and to use them in our work. Thus there has been no urgent need to carry on hybridisation experiments. The high quality of the *paulistana* hybrid and the absence of variation after the third generation suggests there are practical and theoretical possibilities in controlled hybridization experiments, that would reward further study".

---

*Edmundo Navarro de Andrade: The Eucalyptus in Brazil, Jour. Heredity., 32, 220, 240, 1941.

It is hoped that in the work of obtaining dual or multi-purpose trees, besides pursuing introductions of new species of eucalyptus, hybridisation will also be attempted in India, among species which have already been established, and whose qualitative characters and performances are known, so as to combine worthwhile characters, useful for the Nilgiris and other suitable places in India. Eucalyptus is one of the species which will reward systematic work as well as patient and persistent investigation.



Potato varieties on show at Government Botanic Gardens, Ootacamund.

6. POTATO ON THE NILGIRIS

by Sri K. HANUMANTHA RAO, B. SC. (Ag.)
and Sri M. D. AZARIAH, B. SC. (Ag.)
Agricultural Research Station, Nanjanad

INTRODUCTION

Potato is one of the most widely cultivated food crops in western countries. About one quarter of the food of people of Europe and European settlers outside Europe is comprised of potato. Potato leads the other crops in the world's total production of food crops. Compared to other food crops, potato gives relatively high yields, ranging from 5 to 10 tons per acre, and enhances its agricultural importance. Industrially potato is valuable for the manufacture of starch.

In India the present area is estimated at 5 lakhs of acres and it remains a vegetable of great value to both rich and poor. While in the state as a whole, potato is a minor crop confined to 20,000 acres, it has occupied particularly in recent years a pre-eminent place in the agricultural economy of the Nilgiris which has the distinction of possessing almost all the area of potato in the state.

HISTORY

The original home of potato is Peru and Chile in South America where even today wild forms of this crop are found. Potatoes seem to have been introduced into India early in the seventeenth century. Potato growing on the Nilgiris is over a century old. The first introduction of potatoes to the Nilgiris is traced to Mr. Sullivan, the founder of Ootacamund. In 1822 he had procured a professional gardener "with a view to making experiments in horticulture and agriculture under his superintendence." It was also his idea that "the experiment may eventually prove useful to the public and the expense of making them will be my own." Mr. Sullivan obtained from the government, permission to enclose about 1000 acres of waste land for this purpose in the valley south of Stonehouse hill. The gardener was Johnstone and he had

an assistant, an African, named Jones. Potatoes are said to have been grown in this area and in 1824 a potato weighing 5 pounds is recorded as having been harvested by Mr. Sullivan.

Dr. Baikie mentions in his book "Nilgheries" published in 1834 that three and even four crops of potatoes can be taken in a year near Wellington. In 1847, Major Ouchterlony mentions a report that Ceylon offered a very favourable market for the Nilgiri potatoes. In that year there were 186 acres under potatoes, the total output being estimated at 29,300 maunds. An acre of potatoes produced upto 600 maunds and the ratio of crop yield to seed was 15 : 1. This is an extraordinary good yield considering the present day figures.

In 1848 the Government Botanical Garden was established and for some years cultivation of potatoes was one of its chief features. In this garden, new varieties were tried and the ryots were shown how to cultivate potatoes. The cultivation of potatoes was increasing in extent and in 1876 there were 754 acres. Potato was grown on a small scale by the European settlers and on an increasing scale by the ryots. By the end of the last century, Nilgiri potatoes were being exported to Ceylon, Burma and Straits Settlements and potato had become a paying crop. Mr. W. Francis, a Collector of the District evinced very keen interest in improving the quality of potatoes produced on the Nilgiris, and in 1909 he was able to get a grant from the government to import two tons of good seed from Australia. New varieties were tried in the Government Botanical gardens, and in 1910 there were 1½ acres and in 1914 about 2½ acres under potato in these gardens. Seed produced here was supplied to the public and it is said that the average annual supply of seed to the public during the period was over 350 maunds. In 1915 and 1916 the question of expansion of seed production was under discussion and in 1917 the government established an experimental station at Nanjanad on the Nilgiris for undertaking research work on potato and production of larger quantities of seed.

Since 1910 the area under potatoes has been increasing owing to demands from Colombo, Bombay and Calcutta and

other places. From the beginning of the Great War in 1914, there was particularly marked increase in area. The area under potatoes in 1914 was about 4000 acres and it increased to 8,000 by 1920. In 1938 the area rose to 12,000 acres and the present area is estimated at 20,000 acres.

CLIMATE

No other district in the Madras Presidency presents a more varied climate and range of rainfall than the Nilgiris. Gudalur taluk is the wettest of the three taluks comprising the district; the annual rainfall being about 160 inches of which nearly 130 inches are received during the South West monsoon. The moisture-laden South West monsoon wind strikes the western ghats at Devala where the heaviest rainfall in the district is recorded. Further east in the Ouchterlony valley, the annual fall drops to 90 inches of which 70 inches are received in the South West monsoon period. At Naduvattam on the crest of the plateau, the total rainfall again rises to 102 inches of which 79 inches are received during the South West monsoon. As the wind blows eastwards across the plateau, less and less rain is deposited until its course is checked by the Doddabetta range. Thus during the South West monsoon, places lying west of Doddabetta receive a heavier rainfall than those situated to the east of this range, while during the North East monsoon the process is reversed and portions to the east receive more rain than the area to the west of the Doddabetta. The average rainfall of the district is about 67 inches, of which 50 per cent is received during the South West monsoon and 30 per cent during the North East monsoon period while 20 per cent is received as summer rains, thus assuring a fair distribution of rain throughout the year.

The climate of Gudalur is moist and warm and unsuitable for potato cultivation, while that of Ootacamund and Coonoor is favourable for large scale cultivation of potatoes. Frost is very common in Ootacamund during the winter months, but Coonoor hardly ever experiences frost on a large scale.

SEASON

There are three well-defined seasons for potato crop on the Nilgiris. The early crop is grown under irrigation on a a small scale between February and May over an area of about 1,500 acres. The main crop which is extensively cultivated is planted in March–April (kar bogum) and harvested in August–September. The second crop is raised between August and December (Adi bogum). Both the main and second crops are purely rainfed and cover areas of about 11,500 and 7,000 acres respectively at present.

ROTATION

There is no definite system of crop rotation followed in the district. The ryots practise a sort of shifting cultivation and fallow their lands from one to three years. Sometimes a cereal like samai, korali (an inferior millet) or ragi is raised after a potato crop.

SOILS

The soils of the Nilgiris formed from laterite rocks are generally poor in plant food. They are highly acidic (pH 4·6) and contain a large percentage of iron and aluminium which render phosphates unavailable for plants. A well drained deep friable red loam is best suited for potato crop. It prefers a soil of moderate to high acidity with only a moderate content of lime.

METHODS OF POTATO CULTIVATION ON THE NILGIRIS

The local method of cultivating potato is entirely by the use of manual labour and no cattle power is utilised at any stage of the cultivation. Usually the richest land available is selected for planting potatoes. The land is cleared of the scrub jungle and forked deep. The clods are broken and the soil is brought to fine tilth. On the day of planting, the land is made into small ridges and furrows up and down the slope 15 to 24 inches apart by a two pronged mamutti fork or *gudali*. The furrows are 4 to 6 inches deep. The length of the ridge is

usually 3 to 5 yards and a catch drain is opened along the contour. Whole tubers varying from ¼ to ½ ounce are planted 6 to 8 inches apart in the furrows. Five to eight bags or 1000 to 1600 pounds of seeds per acre are used.

The crop is heavily manured with concentrated manures and available farm yard manure. An average dose of 3 to 5 tons of cattle manure and 10-16 cwts. concentrated manure mixture are given per acre. The cattle manure is applied in the furrows, the seeds are planted therein and the artificials strewn over them and covered with earth. The inter-cultivation consists in giving two courses of hoeing and earthing up, the first when the plants are 6 inches high and the second and the final just before the crop begins to cover the ground.

METHODS OF CULTIVATION AT THE NANJANAD RESEARCH STATION

The major portion of the cultivation at the Research Station, Nanjanad, is carried out by bullock power. Two deep ploughings are given with the "Victory plow". Cattle manure at the rate of 4 to 5 tons is applied broadcast and covered with 'Monsoon plough'. Furrows are opened by the double mould board plough at 2 feet 3 inches apart almost on contour. This allows surface water to flow away slowly and tends to prevent surface wash found in the ryot's method. 1610 pounds of artificial fertilizers (consisting of a mixture of 500 pounds of ground-nut cake meal, 336 pounds of concentrated super phosphate, 350 pounds of steamed bonemeal, 224 pounds of sulphate of potash and 200 pounds of ammonium sulphate per acre) are applied on the furrows. The seed potatoes are then covered by splitting the ridges with a double mould board plough. The handy cultivator is worked within ten days after planting with a small plank tied across the rear end of the implement to knock off the tops of ridges thereby killing off germinated weeds and saving a hand weeding. The potato sprouts then come through quickly. The same implement without a cross plank is used again whenever the weeds are found coming up in the furrows until the first earthing up. Two earthings are given, the first when the plants are 6 to 7 inches high and the second before

the crops cover the ground. Deep earthing up is practised in wet weather in order to prevent the potatoes in the ridges from being affected by excessive moisture. The crop is lifted by potato digger plough and the tubers are gathered, allowed to dry and graded into *table, medium* or *seed, chats* and *rejected.* The seeds are generally stored in store-rooms fitted up with permanent wooden racks or small wooden trays when the lots are small.

SEED SUPPLY FOR PLANTING

The main crop, forming nearly two-thirds of the total area under potatoes in the district is planted in April–May and harvested in July–August and supplies seed for planting late second crop of potatoes and the irrigated crop. The irrigated crop provides seed for the second crop of potatoes and the second crop supplies seed for the main crop of potatoes. The weakest link in the chain of seed supply at present is usually the irrigated crop, which supplies only a limited quantity of seeds for the second crop.

PESTS AND DISEASES AND THEIR CONTROL

The most important pests and diseases are mentioned below :—

The potato moth: This attacks potato tubers both in the field and in storage. In the field, damage can be prevented by deep earthing up, so as not to expose the potatoes and facilitate the laying of eggs by the moth. In the store, light traps may be set up to which moths are attracted and killed.

Plant lice: The sprouted tubers kept for seed in the store are sometimes attacked by plant lice. These not only lower the vitality of the seed by sucking the juice from the sprouts but may act as carriers of virus diseases.

Ring disease: This causes the whole plant to wilt and die suddenly. On cutting the tuber, a brown ring near the skin and running parallel to the skin is noticed on the cut surface. Not only is the yield reduced but the diseased tubers lose their flavour also. Disease free seed should be used to

prevent further infection of the soil and a good rotation followed to prevent the spread of the disease. An excessively wet or water logged condition of the soil should be prevented as the disease easily spreads under wet conditions. Disease resistant varieties of potatoes may be cultivated and all rotten and diseased potatoes in the field should be gathered and destroyed by burning or burying deep. They should not be thrown into the manure pit.

Early Blight: Small isolated pale brown spots appear scattered irregularly over the leaf. The reduction in yield occurs from the reduced area of the leaf surface. Generally the crop planted with seed more than 3 to 4 months old is severely attacked at an early age especially in rainfed crops. Therefore seed not more than 3 months old should be used. Spraying with Bordeaux mixture prevents the disease.

Rhizoctonia and *Fusarium* cause rotting of potatoes.

Other pests: Rats, pigs and porcupines cause considerable damage by digging out and eating the tubers. Rats can be controlled both in the field and in the store by systematic use of rat trap and poison baits. The other two are kept away by adequate fencing around the cultivated fields with wire and wire-netting, building stone dykes and digging trenches along the boundary.

MARKETING

Marketing is generally done as soon as the harvest is over. In the majority of cases, the middlemen who supply fertilizers on credit to the growers insist on purchasing the potato crop. Thus the grower suffers under the double disadvantage of paying a higher price for his manure and not being able to sell his produce in the open market. The potato trade is mostly in the hands of merchants of Mettupalayam.

In the Nilgiris, 80 to 95 percent of the produce is assembled at the Mettupalayam market and the remainder at different centres in the hills from where it is distributed by the local wholesalers to various markets. If the prices in the consuming markets are high, a large number of buyers instead of waiting for the produce to come down

to Mettupalayam go to villages and buy the produce directly from the producers. They however, do not do so, when the market is dull and the growers, who want to dispose of their produce, have to take it to Mettupalayam.

However the preoccupation of the cultivator, the complicated market practises and the lack of transport facilities are some of the factors responsible for the cultivator prefering to sell his produce in his own village.

With a view to handle the crop co-operatively and secure better prices for the growers, a purchase and sales society was started at Ootacamund in 1916, which in 1923 converted itself into a Potato Growers' Purchase and Sale Society. For various reasons, this Society did not function well and collapsed in 1925 and the trade remained in the hands of commission agents at Mettupalayam. The Society was revived in 1935 and continues to function now. During 1944 the Civil Supplies Department began making their purchases under an Assistant Marketing Officer at Ootacamund. Due to correct weight and fair prices obtained by the ryots, this organisation was very popular and the purchase during the year 1945 was about 3319 tons, valued at Rs. 8,05,057. During the war, a large quantity of potatoes was being purchased by military departments for army consumption and by Messrs. Parry & Co., for dehydration for military supplies. During 1943, the potato control office was instituted in order to control the transport of potatoes to other provinces and also within the province. Marketing is generally done as soon after harvest as possible. Thus during the harvest of the main crop at the end of July or August, large quantities of potatoes come into the market and prices drop. The potato trade therefore is faced by serious difficulties in supply and demand. If prices could be maintained at a reasonable level throughout the year, both demand and supply would be more stabilised and the ryot would be assured of more steady income.

POTATO IMPROVEMENT — RESULTS OF RESEARCH

The Research Station at Nanjanad was started in 1917 with the object of (1) importing and growing disease-free

potato varieties to test their suitability to the tract, (2) mulitiplying and distributing desirable varieties to the cultivators, (3) evolving a suitable manure mixture for potato, (4) finding out a proper rotation for potato, (5) introducing other crops to find out their suitability to the tract. Selection, hybridization and introduction are three recognized methods of crop improvement. Of the three methods, introduction has yielded good and quick results. Hybridization has not so far proved successful and efforts are being made to intensify this method for potato improvement. Selection is being made to maintain a stock of pure strains and build up the yield.

'Creat Scot' – A Popular Variety on the Nilgiris

By a series of trials of large number of varieties imported from United Kingdom and Australia, one variety 'Great Scot' was found suitable to the tract. Due to its early maturity, cosmopolitan habit, round medium tubers, smooth white skin, fleet eyes, hard flesh and good keeping quality and yield, this variety attracted the attention of ryots and is now the most popular variety on the Nilgiris.

Nanjanad Mixture – A Suitable Manure for Potato

Potato is a quick growing exhaustive crop requiring liberal doses of plant food. The three chemical elements, nitrogen, phosphorus and potassium are essential for this crop. The nitrogen encourages plants to grow, the phosphorus helps to develop their rootlets and hasten maturity, and potash helps to manufacture starch, sugar and fibre. Potato is a potash loving plant. After a series of manurial trials to find out the manurial requirements of the crop, a manure mixture known as Nanjanad mixture suitable for potato has been evolved. This supplies 85 pounds of nitrogen, 215 pounds of phosphoric acid and 108 pounds of potash per acre both in the organic and inorganic forms. According to this formula, an acre of potato crop receives 1610 pounds of manure mixture. The potato cultivators have become highly fertilizer-minded and no crop of potato is grown without the

use of 8 to 10 bags (1600 to 2000 pounds) of fertilizers per acre. As it is, manuring forms one of the heaviest items of expenditure in the cultivation expenses. Experiments to find out the possibility of reducing dosage of manure without impairing yields are under way.

Rotation

A two year rotation is followed on the station. First year, potato crop is followed by a green manure crop of lupin. Second year, a cereal like samai or ragi is grown. Potato crop comes in again during the third year. Experiments conducted for six years to find out a suitable rotation for potato have shown that (1) potato after potato every year gives the greatest potato yield in the early years but its effect on the increase of pests and diseases and the gradual reduction of yield year after year are points to be reckoned with; (2) the cultivation of green manure crop like lupin in the second season every year has maintained the yield of potato; (3) it is more advantageous to take a green manure crop in the second crop season than leaving land fallow; (4) when cereals are taken in rotation with potato, the yield of potato is reduced and this adverse effect can be minimised by the cultivation of lupin after potato but not after cereal; and (5) of the various cereals, samai, ragi, korali and oat tried after potatoes, oat reduces the yield of potato to the greatest extent.

Seed Supply for Second Crop

It has been pointed out that there is a dearth of seed for planting second crop potato during August – September, as the limited area under the irrigated crop has to supply the seed during this season. The early planted main crop will be under harvest at this time, the seeds of which will not be fit for immediate planting. Experiments were conducted to break the dormancy of this seed by treating with various chemicals and utilizing this seed for planting second crop. Carbon-bi-sulphide was found efficacious for this purpose. It was found that treatment of potato tubers

with carbon-bi-sulphide at the rate of 1 ounce for every 32 cubic feet of tubers (4 bags of 200 pounds each) kept in air tight containers or dealwood boxes made air tight by mud and cowdung plastering induces sprouting in 10 days and within another 10 days of resting inside straw after treatment, tubers are found to have good sprouts.

Experimental results indicate that though naturally sprouted seeds give higher yields, the chemically sprouted seeds can also be planted without appreciably reducing the yield. This is a cheap method costing about Rs. 2/- worth of chemical for seed required for planting an acre. This method is now practised by many ryots and is popular in this district. It is estimated that this method supplies seed for about 1000 acres during the second crop season. The entire production over this additional area has been made possible by the results of this research work.

Other Cultural Experiments

The results of some of the important experiments are summarised below.

(1) The economic seed rate to be adopted is to plant medium sized tubers weighing 1 to 2 ounces, 6 to 9 inches apart, in rows 2 feet 3 inches apart.

(2) Freshly sprouted 2 to 3 months old seed is better than 8 months old.

(3) Compost made from green organic matter was equivalent to cattle manure in manurial value.

Soil Erosion – Preventive Method

Due to the undulating nature of the country and cultivation of slopy land, soil erosion is one of the major problems of the tract. The removal of top soil with its organic matter and other nutrients results in the gradual loss of fertility. The worst example of soil erosion of water is found in the Nilgiris. On the outer slopes of these hills, the clearance of natural forests and opening up of land for cultivation of potatoes has resulted in serious soil run-off.

One of the methods adopted at the station to prevent soil erosion is to plant along ridges and furrows formed along contour as opposed to the ryot's method of planting in ridges along slopes. Experiments conducted to compare the yields of crops obtained in cultivating according to farm method and ryot's method has shown that the farm method is definitely better than the ryot's method. In the ryot's method, besides lower yields, the rain water lost and silt washed off have been considerably more than in the farm method. While this experiment was conducted over a gradient of 1 in 10, a study of soil and water run-off under 5 different gradients from 1 in 3 to 1 in 7 has been undertaken by laying out permanent soil-erosion run-off plots with concrete baffle walls and cisterns.

Besides planting potato in the above method, the cultivated area has been demarcated into convenient sizes with field bunds all round. The bunds are planted with kikuyu grass which binds the soil and yields good green grass for grazing and feeding animals. Some of the fields that were recently reclaimed have been laid out into plots with bunds and channels along contour so as to minimise the loss of water and soil washes.

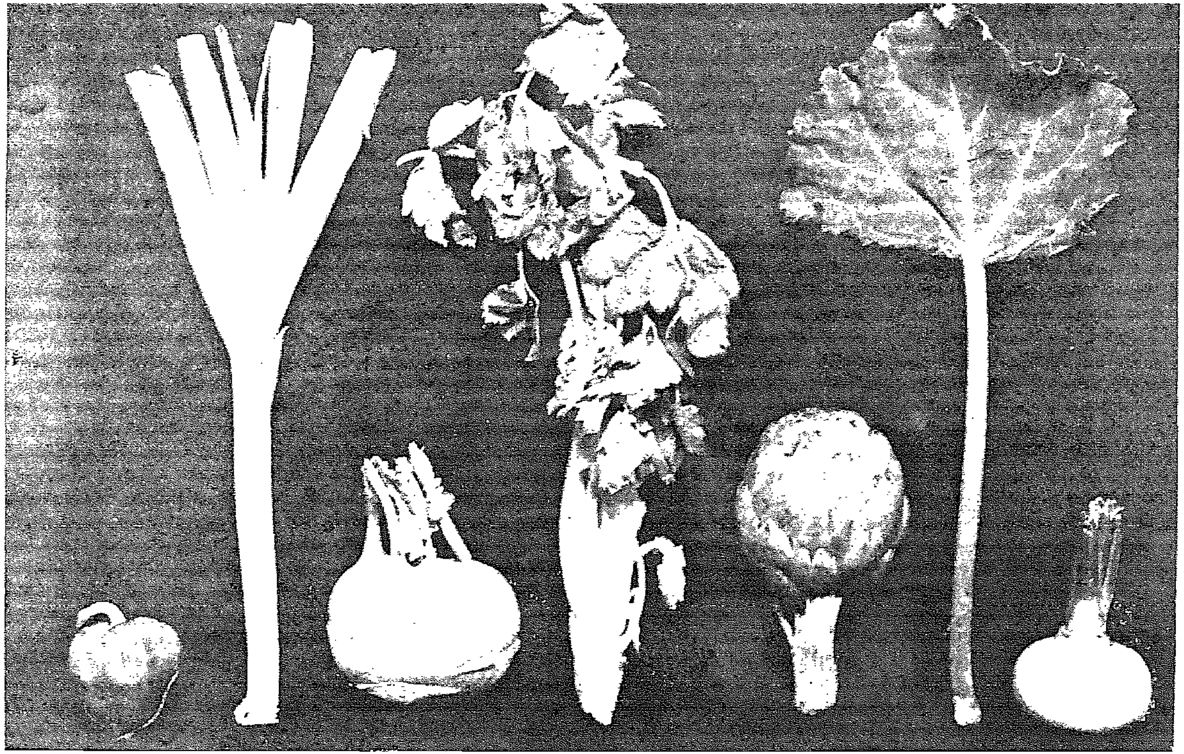
The Use of Animal Power to Reduce Cultivation Charges

The local method of cultivating potato is entirely by the use of manual labour. At the research station most of the cultural operations are done by cattle and implements. The land is ploughed with Victory plough. Ridges and furrows are formed by double mould board plough. The inter-cultivation is done by a cultivator. The potato digger is employed for harvesting the crop. By the use of these mechanical means there is a saving of Rs. 70/- per acre. The cattle power is not only cheaper but efficient. By the use of cattle power it is possible to grow a green manure crop and incorporate the same into the soil to keep up the fertility of the land. The ryots have begun to appreciate the use of cattle power, where the slopes are not steep.

CONCLUSION

The results of research at this station have contributed in a large measure to the improvement of potato growers on the Nilgiris. There are still many problems awaiting solution. Future line of work would consist of collection and trial of a large number of American and indigenous varieties, intensification of breeding programme, introducing seed certification scheme to supply disease-free seed to ryots, other cultural and manurial experiments aimed at reducing manure and seed costs and increasing yields.

The part played by tuber crops like potato in any food production scheme cannot be under-estimated. The possibilities of extending the area under potato at lower elevations await investigation.



Left to right: Capsicum. leek, knolkohl, celery, globe artichoke, rhubarb, turnip.

7. VEGETABLES OF THE NILGIRIS

INTRODUCTION

Vegetables do not seem to have played any important role in the diet of *Todas*, the aborigines of the Nilgiris, whose main stay it is learnt, consisted of milk and milk-products of buffaloes (rearing of which happened to be the main occupation of the Todas), a few wild roots, and wild pepper which to this day is known as "*Toda Chillies*". Later, people from Mysore, subsequently called *Badagas,* (meaning immigrants from the north of the Nilgiris), began to colonise the hills, formed a number of little hamlets, and being good agriculturists, introduced efficient agriculture and succeeded in growing the millets *korali*, *samai* and *ragi* for their main food, and amaranthus and fenugreek as greens and as the only vegetables, in the new environment.

The credit of introduction of a wider variety of vegetables suitable for the cool climate of Nilgiris goes to the next wave of colonists, the British, who came into this hill district during the first quarter of the nineteenth century, and introduced from England plants of numerous varieties of fruits, vegetables and ornamental flowers. The main contribution in this development seems to have come from Mr. Sullivan, one of the earliest British settlers on the Nilgiris, in a village called Dimbatti, near Kotagiri, in about 1820, when he started a garden of his own. In 1821 – '22, he seems to have imported an expert gardener from England and a good number of varieties of vegetables. In August 1825, writing from Ootacamund, he suggested to the Government that a trial sanatorium might be started at Ootacamund for the benefit of the sick and the pensioners among the British servants of the crown. On January 17, 1826, the Government issued orders to make arrangements for accommodating about forty sick British soldiers, and subsequently pensioners were also admitted into the colony. The place thus became a sanatorium under military control, and a fillip was given to the growing of different kinds of vegetables, by distribution of good seeds from England to the

British settlers, and to the local people who were encouraged to grow these new vegetables and bring their produce to the market place for sale. Such temperate vegetables as the cabbage, cauliflower and carrot which thus came to be introduced by the English began to be called the "English Vegetables" or "European Vegetables" and to this day, the names so remain.

As a result of the subsequent withdrawal of the military and their direct support to the colony, vegetable cultivation had a set-back. The remaining British settlers suffered from the pinch in the supply of English vegetables, and therefore formed a small committee and subscribed towards establishing a vegetable garden, solely to supply vegetables to themselves at reasonably cheap rates. Such a garden was established in 1847 in the area which developed into the now famous Government Botanic Gardens of Ootacamund.

Subsequently, vegetable growing became popularised among the indigenous agriculturists, around the other towns which sprang up, such as Coonoor, Kotagiri and Wellington. Among all the English vegetables, what obtained a strong hold in the villages of the Nilgiris among the farmers, was the French dwarf bean which could be harvested sooner than other kinds, and which is even to-day popularly grown by the villagers for their consumption.

The First World War (1914-18) gave additional impetus to expansion in production of English vegetables. Also, increasing communications with the growing towns in the neighbourhood such as Coimbatore, and the direct link of Ootacamund to the Madras City by rail helped English Vegetables of the Nilgiris to be marketed to various outside centres, with the result that to-day, the good quality of English vegetables which are grown extensively on the Nilgiris, has become a house-hold word among the people of Madras State.

During the Second World War (1939-44), the Government Agricultural Department of Madras, in co-operation with the Indian army, began in 1943 to intensify production of English vegetables, and attained a peak in production never reached before, fulfilling for the military alone, a target of 50 tons a day. For this production, 4000 acres were brought under

vegetable cutivation, a large part of it by reclaiming large areas of swamp lands. The technique of production of raising temperate vegetables spread far and wide into remote villages, and this military scheme established the potentialities of Nilgiris for organising intensified production and for marketing the produce at fairly distant markets.

When the scheme was closed after the war, the area of these vegetables was no doubt reduced and in 1949-50, for which statistics was available at the time of going to press, the area under vegetables including peas and beans was 1810 acres, and the Nilgiri district continues to be known as much for the good quality of English vegetables as for its salubrious climate and its international fame as a health resort of scenic grandeur.

The Government Botanic Gardens, Ootacamund, has played a poineering role since its inception in 1848, more than hundred years ago, by systematic introduction and work on these exotic vegetables. When the horticultural work of the Curator of these Botanic Gardens expanded into the whole of Nilgiris, work on vegetables also spread itself into the Pomological Station, Coonoor, which was opened in 1920, under the charge of the Curator, and which later went under the control of the Fruit Specialist in 1941. The Military Scheme of growing vegetables gave an incentive to the establishment of a vegetable research station at Wellington, mostly for meeting problems of seed production, but this research station was however closed in 1949 to the regret of those who are deeply aware of the need for research on these temperate vegetables growing well under a new environment, but which can grow even better, with organised research coming to its aid.

KINDS OF VEGETABLES GROWN

A visit to the markets in the towns of Nilgiris particularly of Ootacamund and Coonoor in summer, reveals the wide variety of vegetables grown, which include Brussels sprouts, cabbage, cauliflower, lettuce, carrot, beetroot, radish, different kinds of beans, peas, knolkohl, tomato, capsicums turnip, globe artichoke, leek, celery, rhubarb, spinach and

sweet corn. But some of these occupy a relatively greater commercial importance than the rest, which are grown on a very small scale to meet very limited demands. The brief notes given below on the cultivation of vegetables relate to methods which have been evolved with some ingenuity by the Nilgiri growers for cultivating foreign crops, whose treatments on the ups and downs of their hills are in many respects different from those observed in temperate countries, where the cultivation of these has gone on for centuries. The notes also contain some additional information of interest to students of botany and horticulture as well as to the growers. The article as a whole is a result of personal investigation with the vegetable growers of the Nilgiris and experience of the author as Curator, Government Botanic Gardens, Ootacamund, and prior to this as Assistant Fruit Specialist, Coonoor, and is meant to stimulate further interest in the expansion of a desirable horticultural industry. Information given on seed-rate and yields of individual vegetables is based on detailed enquiries and depicts the general trend observed. The assistance of Sri M. K. Lingiah, Agricultural Demonstrator, Coonoor, in fixing up vegetable growers for enquiries and his general help in the investigations is acknowledged with thanks.

GENERAL METHODS OF CULTIVATION AND SEASONS

Commercial growing of English vegetables during normal times has been concentrated mainly in and around towns of the Nilgiris over an elevation of 5000 feet. The grower is usually a specialist in commercial vegetable growing, and his vegetable area may vary from a few cents upwards, according to his extent of control of land, availability of labour, water facilities, seasonal demands, nearness to market or accessibility to wholesale dealers.

There are two main seasons generally, when the vegetables are grown viz., (1) January to June, and (2) June to October. The first season of January to June may be considered more important of the two, particularly for many growers who look to increased prices for their produce, due to influx of

visitors in the summer, from the plains, from all over India and from foreign countries. In this season, a greater variety of vegetables is grown and the rains are not so heavy as to spoil the crops.

The digging fork is the main agricultural implement for the growers to prepare the land on the slopes of the hills, where no oxen can easily work and where areas are not large for mechanised cultivation. The *mammoty* helps him to form the beds and channels or ridges and furrows. Vegetable compost, municipal rubbish, and cattle manure form his mainstay for nutrition to his vegetables. He directs, within his limited resources of manurial supply, better attention in this respect, to more paying crops such as cabbage and cauliflower.

Supply of good seeds of high quality is his main problem. From the beginning, for the last one century and more, he has depended on outside supply, firstly from England, subsequently both from England and U.S.A., through the seedsmen in the country, who have been agents of foreign seedsmen. During recent years, with the curtailment of import of seeds from foreign sources, the growers are faced with a serious problem of generally unsatisfactory seeds from the sources in the country who are no longer able to import quality seeds or to produce by themselves seeds true to type and of desirable standards. In cases such as cauliflower, turnip and radish, many growers are able to collect their own seeds, and in others they still depend on these outside sources. All this has reflected in the deteriorating standards of quality of produce.

COLE CROPS

Cabbage (*Brassica Oleracea*, Linn. Var. *Capitata*, Linn.) Cruciferae

The cabbage head used as' vegetable is an enlarged terminal bud. The cabbage is a biennial, though cultivated as an annual crop.

CULTURE

Seeds are sown broadcast on raised level seedbeds of convenient size such as 12 feet by 3 feet, manured with sieved compost about one inch thick and preferably no cattle manure. An improvement is to spread

before sowing, super-phosphate at the top at the rate of one ounce per square yard, working it in, re-levelling and compacting the surface, and watering the beds gently with a rose can previous to the day of sowing. The sowing is done in half-inch deep furrows, 3 inches apart, with one inch between seeds, and the seeds are covered with fine soil, pressed and watered with a fine rose. Preferably, shade is given to these beds in the early stages by spreading some ferns or any convenient material, to protect the seeds from both direct sun and rain, and to help retention of moisture. With the first signs of germination, this cover is removed, and the beds are watered regularly. The seed-rate is estimated at 4 to 6 ounces per acre of planted area. When the seedlings are a month old, they are transplanted in the main plot.

Prior to this, the main plot is prepared with the help of digging fork and mammoty, and small pits generally of 9 inches cube are dug, giving a spacing of 1½ by 2½ feet, varying to some extent, with the varieties to be grown. A mixture of well rotten cattle manure and compost is mixed with the soil, and the pit filled with it and compacted at the ground level for planting. During the first fortnight, hand watering is done preferably with a rose can, every day, till the young seedlings are fairly established. Then ridges are made for facilitating water being let in for irrigation once in 4 or 5 days. Some progressive growers use artificial fertilizers in the following programme viz. ammonium sulphate at one ounce per square yard 3 weeks after planting, potassium sulphate at the same rate between 4 to 5 weeks after planting, followed by a dose of superphosphate ten days later at the same rate. Some apply instead, in 3 or 4 weeks after planting, potato fertiliser sold by commercial fertiliser companies and analysing 6 – 12 – 6. The cabbage is harvested, when the head is felt hard all round when pressed. Estimated on an acre basis, a normal yield is about 15,000 pounds, which depends however on many factors such as the variety, conditions of growth and the care taken by the grower. Often much higher yields are obtained under favourable conditions and good care.

VARIETIES

Cabbage is one of those plants, which show a wider range of variation than most other vegetables. The cabbage varieties can be classified according to duration, shape of head, quality etc. There are early varieties such as *Copenhagen Market Early*, *Golden Acre* and *Chas Wakefield*; there are medium duration varieties such as *Early Drumhead*, and *Glory of Enkhuizen*, while there are late varieties such as *Late Drumhead*. According to shape of head there are three main groups viz. the *Drumheads* (flattened heads) like the Early and Late Drumheads, Copenhagen Market, and Savoy Drum-head, the *Ball-heads* (globular or almost globular heads) like Danish Ball head, Golden Acre and Glory of Enkhuizen, and the *Conical types* such as Jersey Queen and Chas Wakefield. The Savoy group of cabbage is characterised by crinkled foliage and the variety Savoy Drumhead is an example. The *Red Cabbage* group is distinguished from all others by its deep purplish red colour. Cabbages vary also in the nature of compactness of heads, some being loose like Golden Acre, and some compact and heavy like Glory of Enkhuizen. The Chinese cabbage is different from the common cabbage, has the Specific name of *Brassica pekinensis*, the Chinese name of *Pe-tsai*, and resembles to some extent Cos lettuce. All

the varieties mentioned above have been tried on the Nilgiris either by the growers or the farms of the Agricultural Department. But to-day the lack of purity of strains is a pressing problem, for reasons already dealt with before.

PRODUCTION OF SEED

Commercial production of cabbage seed in the Nilgiris is still non-existent. But seeds can however be produced by the following method:

When the cabbage head is hard and mature, the plants are lifted as a whole and kept in shade separately for 24 to 48 hours. Meanwhile, pits should have been prepared and well-manured. The plants are then planted in these holes with their roots intact or partially severed. In the first few days, watering need not be too profuse and the plants must be protected against rain. A fortnight after planting, when the plants are established, the heads are scarred across the top, not deep enough to injure the sprouting centre, but so as to facilitate its pushing its way through the head. Subsequently, the flower stalk emerges with flower formation succeeded by setting of pods, and formation of seeds. The worst enemy of the seed crop of cabbage is caterpillar of the "diamond back moth" (*Plutella maculipennis*) which lays eggs on the young flower buds from which the young caterpillars emerge and burrow subsequently into the pods causing considerable damage, if proper steps for control have not been taken in the early stages. Hand picking of caterpillars as well as pupæ from the leaves before the flower buds appear is a good preventive measure. A suspension spray Geigy 550, 1 in 40, has been also found effective in controlling the pest. When fully dry but before dehiscing, the pods are scissored off and kept in shade before dehiscing. The seeds are dried subsequently in indirect sunlight, preferably to direct sunlight. Among the other conditions for success in seed-production are that the heads are planted in December – January so that the seeds are collected in April – May and that the flowering cabbage plants are kept isolated from contamination with pollen of other cruciferous varieties.

With some slight modifications of this method here and there, seeds of cabbage have been produced at the Research Station at Wellington and the Pomological Station, Coonoor and by a few vegetable growers, but up-to-date, production of seeds of varieties true to type on a sizable scale to meet the demands of seed on the Nilgiris and elsewhere is far from achievement. Moreover seeds thus produced upto now have not been of the desired quality.

INSECT PESTS

Cut-worms, (*Agrotis Spp.*): This is a serious pest of cabbage and cauliflower seedlings. The cutworms are darkish brown and smooth caterpillars and attack the seedlings in the nursery and transplanted plots. The damage is done by its nipping off the seedlings just above the ground level, when the seedlings wither and die out. The pest can be controlled by application of Gammexane D 025 and D.D.T. 5 percent dust. The seedlings in the nursery are dusted; and in the transplanted plot, the insecticide is applied close round the plant after loosening the soil.

Root maggots: These are equally serious pests of cabbage and cauliflower. The cabbage root fly lays its eggs round the stem of the plant, near the soil, and the eggs hatch out a few days later. The maggots are one-fourth

inch or less in length and are creamy white in colour. They first appear near the soil around the stem and later eat their way down to the roots of the plants. The damage is not always at first apparent as the roots are slowly eaten out leading to root rot and subsequent death of plants. It is not easy to get rid of the maggots once they obtain a hold on the roots of the seedlings, and prevention rather than remedy is more effective. Entire areas of transplanted cabbage and cauliflower are likely to be wiped out in about a month, if neglected.

Preventive measures found successful consist of application in the transplanting holes at the rate of ½ an ounce per plant of freshly slaked lime powdered and kept over for a day prior to application followed after a fortnight by the application of a quarter teaspoonful of gammexane D 025 around each plant.

Aphids (*Aphis brassicae*): These plant lice sometimes multiply in large numbers and affect the growing and tender leaves very much. The spread is severe particularly in dry seasons. Spraying with nicotine sulphate to which soap has been added, has been found to be a good control measure. Dusting with nicotine preparations is perhaps preferable.

The cabbage borer (*Hellula undalis*): Sometimes this becomes a major pest. The larvæ are about three-fourths to one inch long and are pale whitish brown in colour. Under continuous wet conditions, these can be observed to be feeding on cabbage leaves and found in between the whorls of cabbage leaves on the plant. Besides feeding on leaves and shoots, the larvae enter the stems and cause the plants to die or cabbage heads to rot. Application of D.D.T. suspension spray Geigy 550, 1 to 40 has been found to be effective in controlling this pest.

DISEASES

Club root (*Plasmodiophora Brassicæ*): The most serious disease of cabbage is the clubroot which is highly dreaded by the growers. One of the symptoms of the disease is the wilting of the plants on hot sunny days and recovering towards evening or on cloudy days. When the roots are examined, the large swelling will be a club-like mass, a characteristic of this disease from which the disease derives its name. Infected plants are very much reduced in vitality and in bad cases, plants are entirely killed.

One of the preventive measures consists of application of hydrated lime to the surface of the soil at 7 or 8 ounces to the square yard. Generally the infection takes place in the seed bed and so, before sowing the seeds, it is recommended that the seed-beds may be watered with a solution of mercuric chloride at the dilution of 1 ounce in 12 gallons of water. Similar solution should be applied, about 10 days later, and another a week hence. When the plants are put out into the holes, a quarter of an ounce of similar solution should be poured into the hole. Another preventive measure is the eradication from the fields and the bunds, of cruciferous weeds which are alternative hosts for this disease.

The spores of this disease are capable of remaining in the soil for many years and in serious cases, a long rotation in which cruciferous plants are absent, will be helpful.

Cauliflower. (*Brassica oleracea*, Linn. Var. *Botrytis*, Linn.) Cruciferæ.

It is one of the most popular vegetables among those who can afford to pay the price, as it is relatively costlier. It is for the white, tender head called *Curd* formed by the shortened flower parts that cauliflower is grown.

CULTURE

The cultivation of cauliflower in a general way is much the same as of cabbage, particularly with regard to sowing in nursery, transplanting in holes, and other cultural operations. The spacing between plants varies with the variety, soil etc. but is normally 1½ by 2½ feet. To get large sized curds, regular hoeing between plants and copious watering during dry weather preventing any check in growth are necessary. One of the most essential operations with regard to cauliflower, to produce a pure white curd is *blanching*. As soon as curds are seen, the outer leaves are brought over the head and tied up with gunny twine or pinned together with a sharp stick. The length of time of blanching depends very much on the weather. Leaves should not be allowed to rot and discolour the head. The heads should be examined very frequently particularly during very hot weather and the heads should not be allowed to push up their flower stalks and assume a "riced" condition, which will reduce the marketing value of the head. Cauliflower is harvested when the heads attain the proper size, but before they begin to "rice" or become discoloured. In harvesting, the plant is cut off well below the head with a large knife. The best way to prepare the head for marketing is to trim the head by cutting squarely with a knife across the leaves leaving half to an inch projecting over the head. This will prevent the heads placed together from being injured by rubbing against each other or the sides of the containers. The average size of a cauliflower as found in the markets is of about 6 inches width, but heads are also seen of one foot width and more. The average yield is estimated at about 6,000 pounds per acre. Much higher yields are known.

While growing cauliflower is highly profitable, in fact more profitable than cabbage, commercial growers who depend on markets in the plains would prefer to grow cabbage in its place, because cauliflower does not stand storage and transit properly, and any delay in marketing will result also in "ricing" of the heads, resulting in loss. A grower who has the access of a nearby market will find it more profitable to grow cauliflower in preference to cabbage.

VARIETIES

While in the early days no doubt, many foreign varieties were introduced, the growers have learnt in recent years to collect their own seed from the best heads from their bulk crops. Lacking in the technique of building up pure types of seeds, a commercial crop to-day in the growers' fields represents a mixture of types. The writer found with some growers their own stocks of seeds of early and late acclimatised strains. The Early Snow Ball is a variety maturing in about 70 to 80 days after transplanting and late varieties take 4 to 4½ months. The Pomological Station, Coonoor, grows a variety called "Pomocol", which is the station's selection and matures in four months. The grower has to be particularly careful in the source of seeds, as often *bolting* is seen in cauliflower due to the wrong type of seeds, unsuitable for the climate.

SEED PRODUCTION

While seeds can be produced as in cabbage, by lifting plants and re-planting in a new situation, the plants can be left in situ for seeding. The compact heads "rice" and individual flowers will come out within one month after the mature heads appear and the seeds can be harvested in another three months. It takes about 8 to 11 months from sowing to collection of seeds depending on the variety. In the acclimatized types, upto 8 ounces of seeds per plant have been obtained. Here also, it is important to isolate the plots for seed-production from contamination of pollen from other cruciferous plants.

INSECT PESTS AND DISEASES

The cauliflower suffers from almost the same insect pests and diseases as the cabbage. Comparatively the cabbage is known to be affected more severely by club root and the aphids. In the case of aphids, it is explained that cauliflower leaves are more exposed to the sun and aphids do not find this congenial. In the production of seed, if the grower is not more vigilant, the seed-pods are badly affected by the diamond back moth caterpillars, reducing the yield of seed.

Brussels Sprouts. (*Brassica Oleracea*, Linn. Var. *Gemmifera* DC.) Cruciferæ.

Brusels sprouts are grown for the edible buds or small cabbage-like heads which grow in the axils of leaves and derive the name from the fact that they have been grown near Brussels in Belgium since time immemorial.

The cultivation methods are similar to those of cabbage and cauliflower. Compared to the extent of area under cabbage, the area under Brussels sprouts is small but these sprouts fetch high prices. It is a crop which requires good but not too heavy manuring for proper growth and production. The best method of picking the sprouts is to break the leaf below the sprout and remove the sprout by breaking away from the stalk. With the removal of lower leaves and sprouts, new leaves arise on the top and with them a bud or sprout in the axil of each leaf. Harvesting the lower sprouts hastens the maturity of sprouts farther up the stem.

The plants can be allowed to remain for two or three years and may be grown on bunds. In the fields, a spacing of 18 inches in the rows and 30 to 36 inches between the rows can be adopted.

KnolKohl, Kohlrabi or Turnip Rooted Cabbage. (*Brassica oleracea*, Linn. Var. *Caulo Rapa*, DC.) Cruciferae.

It is also a member of the cabbage family but the edible part of the plant is the swollen, fleshy stem which forms a turnip-like growth just above the surface of the ground. It is cooked and used like turnips and many consider it superior in flavour and quality to turnip.

CULTURE

Cultivation is similar to that of cabbage and cauliflower. While a spacing of 6 inches in rows 18 inches apart is quite suitable, there are

growers who give an average spacing of only 6 inches either way. The early varieties are harvested in about 3 months of sowing and late varieties go upto $4\frac{1}{2}$ months. Plantings made at 2-week intervals will ensure a continuous supply of tender knolkohls. Knolkohl is harvested before it becomes tough and woody. When harvested, the roots are cut off and the plants are tied together in bunches and sold in the market. An acre yield of 10,000 pounds must be be considered good.

VARIETIES

Knolkohls are of two types, the green and the purple, the green being generally the more tender of the two. The two types are exemplified by the varieties White Vienna and Purple Vienna. There are early and late Viennas. The growers are aware of these varieties.

SEED PRODUCTION

Production of seeds has been a problem. The writer saw some plants of knolkohl near Coonoor shown by a grower who let them grow for months together in the hope of producing flowers but only vegetative growth continued. It is also a biennial like cabbage.

The plants are not affected very seriously by insect pest and diseases.

ROOT CROPS

Beet Root. *(Beta vulgaris,* Linn.*)* Chenopodiaceae

It is a biennial producing a thickened root (which is the edible portion) and rosette of leaves the first season, followed in the next season by flowers and seed in suitable environment. The so-called beet seed is really a fruit containing usually two to six seeds which are small, kidney shaped and brown. Seeds retain their germinating capacity for 5 to 6 years.

CULTURE

Beets can be sown in situ or transplanted after raisings seedlings in seed beds. If properly sown, a seed-rate per *acre of about 3 pounds for* direct sowing and of about $1\frac{1}{2}$ pounds for nursery sowing should be adequate. Like all root crops, the beet needs a loose, rich soil in the best condition of tillage, No fresh or fermenting manure should be used. Fully rotten cattle manure or compost with some good potash fertiliser is good for beet root. Since the so-called seed or "*seed ball*" consists of upto six seeds, thinning of the plants becomes necessary, regardless of the rate of sowing adopted, or uniformity of sowing. After thinning, the plants remain 4 to 6 *inches in the rows,* 18 inches apart. The duration from sowing to harvest is from two months upwards according to variety used. Harvesting depends largely upon the size of roots desired. Very often harvesting can be a thinning process, with the larger ones being removed, giving space for smaller ones to develop. The beets are pulled by hand and the injured and dead leaves removed, and then four to six beets are tied together with the tops on, and washed to remove any

adhering soil. Bleeding of the roots or loss of colour while beets are cooking, can be prevented by cutting off the tops about one inch above the crown of the roots. An acre yield of 10,000 pounds indicates a good crop. Much higher yields are also abtained.

VARIETIES

Detroit Dark Red and Crosby's Egyptian are well known varieties. Detroit Dark Red is deep blood red and comparatively late variety, and Crosby's Egyptian is lighter red and early. Varieties of beetroot also show variation in colour of root both outside and inside, in shape of root such as globe and flattened globe, and in the colour and type of leaves.

SEED PRODUCTION

Trials with seed production in beetroot in the Nilgiris have shown that the Ootacamund area and the Coonoor area react differently. While seeding is done comparatively easily in Ootacamund, it is not so in the Coonoor or Wellington area where prolonged vegetative growth continues without throwing out flower stalks. Imported seeds do not set seed easily even in Ootacamund, while acclimatized seeds perform better.

The following method is adopted for raising a seed crop :—

The roots when mature for harvest as vegetable, are left in situ and the suckers appear. At this stage, the plants are given a check in vegetative growth by withholding water for about fifteen days, coinciding with the dry weather in January. Then the roots are lifted and the shoots trimmed without any injury to the terminal buds. The lower one-third of the root (edible portion) is cut off transversely and the rest of the material is allowed to rest in shade for 24 to 48 hours. Meanwhile, pits of one foot cube are dug and filled with well rotten cattle manure to a depth of 6 inches at the bottom and with soil in the rest of the pit. Soil is scooped out on the surface to provide space for the root to be planted so that the terminal bud is just above the ground level, and so that the root sits on a layer of sand, applied prior to the root being planted. The soil around the plant is now packed well. Watering is done from then on carefully and judiciously for about 15 days. New shoots spring up, with subsequent good vegetative growth and the roots also begin to swell and grow big. After this, the flower stalks appear and seeds are set, which are collected when ripe and brown.

In some cases bolting is seen in beetroot, where the beet plants shoot to seed before the roots reach proper size for marketing. Seeds from such plants should not be used for raising crops of beets.

PESTS AND DISEASES OF BEET

The leaf spot disease caused by *Cercospora beticola* is common on beetroot; and this causes spots of ashen gray colour surrounded by a purple border, which drop out presenting holes on the leaves, resulting in a large part of green tissue being destroyed. After harvesting, all the leaves must be swept out and burnt and proper rotation must be followed. Spraying with Bordeaux mixture has some control effect.

Carrot. (*Daucus Carota*, Linn.) Umbelliferae.

It is a biennial and produces in the first season a thickened root which is the edible portion and a whorl of leaves, and in the next season, the flowerstalk starting from the crown and growing to a height of 2 to 3 feet.

CULTURE

The carrot is grown from seed sown where the crop is to mature. Continuous supply of carrots during the growing season may easily be obtained by sowing at intervals. The local practice on the Nilgiris is to broadcast the seeds rather thickly and when the seedlings have grown to one or two inches, thin them lightly. 2 to 4 pounds of seeds should be enough per acre. An average spacing of 4 to 6 inches either way is considered ample by the growers. Unless seeds are obtained from proper source, bolting may be met with, the plants flowering without forming any tuberous roots. Keeping the fields clear of weeds prior to sowing and throughout the growth of crop is most essential for successful production of carrots. Too much manuring and watering have been said to cause forking of the edible roots, which is not desired by consumers. When harvested, the carrots are usually bunched, washed and sold. On an acre basis, 7000 to 10000 pounds of roots can be harvested under normal conditions. Higher yields are also obtained.

VARIETIES

The varieties of carrot fall into three main classes – the *Short* carrots, the *Intermediate* or *Half Long* carrots and the *Long* carrots. The colour of carrots may be yellow, orange, red or purple. There are also the early and late varieties having durations of 8 to 10 weeks and about 4 months respectively. Among the varieties, with which the Government farms on the Nilgiris or the growers have been familiar are the *Imperator*, a long type, with comparatively long duration, *Chantenay* of medium duration, and *Ox-heart* of comparatively short duration.

SEED PRODUCTION

The method of seed production in carrot is much the same as in beetroot. The roots must be planted as in the beetroot during dry weather 3 feet apart. Each plant gives rise subsequently to a number of umbels which develop into seed which is collected and dried. Carrot seed does not shatter seriously, and the fact that the apical flower head blooms and seeds earlier than the axial or side heads, should be borne in mind. If the seeds are harvested too soon, a large percentage of small immature seed will develop.

PESTS AND DISEASES

Carrot does not suffer from many insect pests and diseases. The leaf blight caused by the fungus *Macrosporium Carotæ* may however be mentioned, control measure against which is a spray with Bordeaux mixture.

Radish (*Raphanus sativus*, Linn.) Cruciferae.

CULTURE

It is one of the most easily grown and most rapid growing vegetables. Roots of edible size can be produced within 4 weeks from time of sowing in some early varieties. A succession of several crops within a season can be obtained by sowing at intervals of ten days. Mixing of seeds of radish with those of turnip and broadcasting them is also in vogue. Radish is directly sown in the plot. When sown pure, 4 to 6 pounds of seed per acre should be more than adequate. It is better that the seeds are not planted more than one-half to three-fourths of an inch deep. Germination takes place rapidly, if soil moisture is adequate. A constant supply of moisture is necessary for production of good roots. If the soil is allowed to dry out, the roots became pungent and pithy or soft. Harvesting is done as soon as the roots reach edible size, but before they become pithy and soft. Radishes are pulled by hand and tied in bunches of 6 to 12 of smaller varieties and 3 to 6 of larger varieties. After being bunched they are washed to remove the soil. 10,000 to 15,000 pounds of radish per acre are good yields. Higher yields are also obtained.

VARIETIES

Radish varieties vary in colour, being red, red-and-white (red outside and white inside), and white. On the Hills, the red is preferred. They vary in shape, being round, oval and long. They vary also in size. Among the varieties with which the Government farms and the growers have been familiar are the Scarlet Globe, a very desirable early variety, globe-shaped, bright scarlet in colour, tender, crisp and mild in flavour, and Scarlet Forty Day variety, and the French Icicle.

INSECT PESTS AND DISEASES

Radish does not suffer very much from insect pests and diseases.

SEED PRODUCTION

For seed production, roots can be transplanted as in the case of carrots or turnips, but they will also produce seeds easily, if they are left in their original plot after discarding all unselected roots. It takes about four months to produce seeds from the time of sowing. There is no danger of radish seed shattering when ripe. Varieties of all colours and shapes will pollinate with one another. Consequently, they must be grown well apart. Roots of the best shape and colour, which mature early and have the smallest tops, should be selected as mother roots.

Turnip (*Brassica Oleracea*, Linn. Var. Rapa, Linn.) Cruciferae.

CULTURE

The method of cultivation of beetroot, carrot, knolkohl or radish would be suitable for turnip. It is sown broadcast directly in the ground where the crop is to mature. About 2 pounds of seed should be more than adequate per acre. The spacing allowed is quite as close as in the

case of knolkohl. The soil must be well supplied with water. Slow growth or a sudden check to growth through lack of water will cause the roots to be tough or woody. Lack of water is one of the chief causes of bitterness in turnip. Some varieties of turnips can be harvested within two months. The method of harvesting is the same as in beets. An acre-yield of 10,000 pounds and more can be obtained under favourable conditions.

VARIETIES

Purple Top, White Globe, Snow Ball are among varieties whose performance has been good. In Purple Top, the roots are reddish purple above the ground and white below and the flesh is white, fine grained and of the best quality. Snow Ball is a pure white variety.

SEED PRODUCTION

Growers know to collect their own seed. It can be done in the following manner:

Turnips when mature are removed with the tops cut, but without the rootlets removed, and they are transplanted in holes 1½ feet in diameter and 1½ feet deep, prepared previously, with well rotten cattle manure put in at the bottom and covered at top with two inches of soil. Three feet spacing is given between pits. In three months after this, seeds are obtained. Crossing takes place between turnip varieties but not between turnips and cabbage or cauliflower. Harvesting and preparation of seed are as in other Brassicas.

INSECT-PESTS AND DISEASES

Turnip does not suffer from very serious pests and diseases.

PEAS AND BEANS

Peas (*Pisum Sativum*, Linn.) Leguminosae.

Peas are among the most popular vegetables and are grown for their edible seeds. It is a rich man's crop and essentially a cool weather crop, sensitive to heat.

CULTURE

Peas are dibbled in lines in well dug and and well prepared beds or shallow furrows about 2 feet apart, giving a spacing of three inches between seeds. Spacing and methods of sowing vary in practice, according to whether a dwarf or tall variety is grown and according to other considerations. The beds should have been manured with well rotten cattle manure. Ordinarily, the depth of sowing should not exceed an inch and a half. A seed rate of upto 40 pounds per acre may be required. A continuous supply of peas can be obtained by sowing early, mid and late varieties. Too deep sowing results in slow growth and poor stand. When the plants are about six inches tall, they give out tendrils and at this stage along the rows brushwood proppings are provided for the plants of tall varieties of peas to run up the props.

Supporting vines in the case of tall varieties has certain distinct advantages. Weeds can be removed properly, intercultivation is possible and pickings become easier, as the pods would be adequately exposed to view. Subsequent irrigations should be fairly frequent, but not too heavy as water logged conditions induce root rot. Peas should be harvested when the pods are well filled but before peas begin to harden. Many varieties of peas mature their pods over a relatively long period and successive pickings are required. Peas lose their flavour rapidly after they are picked, and hence should be used fresh. A yield varying from 600 to 1000 pounds of seeds may be obtained.

VARIETIES

Varieties are many in peas. There are the smooth seeded and wrinkle-seeded varieties, which are the two main groups in peas. There are again the early, middle season and late peas. Then again, there are the tall and the dwarf peas, and it can be generally taken that the Earlies are dwarf and the Lates are tall, dwarfs growing as short as one foot high. Among the varieties introduced for trial on the Nilgiris were the Early Giant, Telegraph, Duke of Albany and Green American, There is the local variety on the Nilgiris called the "country variety" with small pods containing small seeds with comparatively insipid taste.

SEED PRODUCTION

In production of seed in peas, emphasis is on the necessity for preserving trueness to type by discarding all rogues or off-types. Most varieties of beans and peas are not to any extent subject to cross fertilisation. Therefore, multiplication plots of the different varieties need not be widely separated. The pods should be left until fully ripe before harvesting. It is better to harvest the pods early in the morning, when the dew is still on them ; they are less likely to shatter. The pods should be dried until quite hard, before shelling.

PESTS AND DISEASES

A disease which is often serious on peas is the mildew whose dense mycelia cover the leaves, stems and pods. Sulphur dusting is a curative method which is effective. Fusarium wilt is another, against which there are disease-resistant types.

Bean. French, Kidney or Common Bean (*Phaseolus vulgaris*, Linn.) Leguminosæ

Of all the different kinds of beans, the common bean, *Phaseolus vulgaris* is commercially most important on the Nilgiris. In this there are two main types, the bush called the *dwarf beans* and climbing types called the *runner or pole beans.*

DWARF BEANS

The growing of dwarf beans is widespread all over the Nilgiris, even in the remote villages. There is perhaps no indigenous household which does not raise a crop of beans. The tender pods are cooked, and the mature dry seeds are stored and used frequently as substitute for the common gram and pulses of the plains.

CULTURE

Bush or dwarf beans are rather sensitive to wet and cold weather and to heavy dew fall. For growing dwarf beans, soils with moderate fertility but good drainage are suitable. For sowing, beds of convenient size are prepared and cattle manure is applied at the rate of 20 to 40 cart loads according to the soil needs and availability of manure. The beds are levelled and compacted. The seeds are then dibbled in lines about one inch deep with a spacing of 6 inches in the rows two feet apart. A seed rate of 40 pounds per acre should be adequate. Germination takes place in about six days. Flowering starts after about a month and pods will be ready for picking in forty-five days. Since bearing period is prolonged, frequent pickings are necessary. The beans should be harvested when the pods are immature and tender. If the seeds are allowed to develop to full size, most varieties get tough and fibrous. A good bean has a thick meaty pod which snaps off clean when broken, leaving no string along the back. It is a short duration crop maturing in about two months for tender pods and in about three months for seeds.

VARIETIES

Various types of dwarf beans are found, varying in colour, size and shape of seed. Among foreign introductions under trial in the Nilgiris have been Bountiful, Chocolate, Premier, Superlative, Mottled Red and Speckled Brown.

The standard classification of the bean varieties is based on the method of use of the bean and also the colour of the pods. The groupings according to use are (1) the snap beans grown for the edible pod; (2) green-shell beans, used in the green shell condition; (3) the dry shell beans, used in the dry state. Regarding colour, there are the green podded, and the yellow- or wax-podded varieties. Based also on the shape of seeds, there are the kidney, marrow, medium and pea types.

POLE BEANS

CULTURE

For cultivation of pole beans, the growers prepare small circular beds which are well manured. The seeds about 4 to 6 are dibbled in the periphery of the circular bed. Just when the plants have grown up and show a tendency to twine, four or five poles about 8 feet long are driven close to the plants and the ends of the poles are brought together and tied at the top so that they form together the frame work of a cone on which will spread the runners.

PESTS AND DISEASES

While there are not many pests and diseases on the beans, there is a disease which is often called "rust" but which is actually 'Anthracnose' caused by the fungus, *Colletotrichum lindemuthianum*, attacking the stems, leaves, pods and seeds. Cankers are found on the stems and leaf veins; rounded or irregular sunken spots are formed on the pods. In serious cases, the pod may be completely covered with spots, with no seed being produced. In some cases, the fungus even penetrates into the seed and

causes dark spots on them. If the seasons are characterised by heavy rains, the severity of this disease is increased. Control measures against this have been found difficult. Use of disease free seed and anthracnose resistant varieties will be helpful. Diseased seed and refuse from diseased plants must all be burnt to prevent carrying over the fungus from season to season.

Seed production is similar to that in peas.

OTHER BEANS

There are other beans such as the Broad bean (*Vicia Faba*) which is an erect growing plant, producing very large and usually flat, orbicular or angular seeds; the Lima bean (*Phaseolus lunatus*), which is a tall climbing plant, producing large flat seeds, the Scarlet Runner bean (*Phaseolus multiflorus*, Willd) which is a perennial plant. All these are of minor importance compared to the French beans.

OTHER VEGETABLES

There are other vegetables which are grown to a lesser extent on the hills of the Nilgiris. Due to limitation of space, only the more important of them are dealt with very briefly below:

Lettuce (*Lactuca sativa*, Linn.) Compositæ.

Lettuce is a salad crop and an annual, with five types, (1) the *leaf* varieties which do not form heads and have large and crumpled leaves with wavy or frilled margins. (2) the *Crisphead* varieties which form solid cabbage-like heads, (3) the *Butter-head* varieties which form heads more or less spongy or bunched, with inner-leaves of the heads blanching to a very light yellow, and oily or buttery to the touch. (4) the *Cos* (Romanie) varieties forming long narrow upright heads, (5) *Stem-lettuce* varieties which are of recent origin in U. S. A., with not only edible leaves but in addition with thick, fleshy stems which can be peeled and eaten like celery. Seeds are first raised in the seed beds, then transplanted in main plot. The crop responds well to good manuring and cultivation. Harvest is done by cutting off the plant just below the head at the proper stage for marketing.

Spinach (*Spinacia Oleracea*, Linn.) Chenopodiaceae

This is an annual, grown for its foliage for "greens". It can be grown pure or as a companion crop with peas, cabbage and such other comparatively longer duration vegetables. Seeds can be sown either directly or first grown in seed bed and then transplanted. Harvesting is done by cutting off the entire plant just above the soil surface but it can also be done by pulling leaves from the plants as needed, particularly in home gardening.

Sweet Corn. (*Zea Mays*, Linn. Var. *Rugosa* Syn. *Zea Saccharata*, Sturt) Graminæ

In the summer, there is some demand on the Nilgiri hills for sweet corn and it fetches good price. Some growers specialise in growing this for the market. Excluding the edible bamboo, sweet corn is the only other vegetable of the grass family, Graminae. Sweet corn has a higher sugar content in the milk stage than the common field corn. Sweet corn is grown almost in the same way as the field corn. The individual cobs are picked at milk stage, as soon as the kernels become well filled and plumpy.

Tomato (*Lycopersicum esculentum*, Mill.) Solanaceae.

Tomato is grown on the hills of the Nilgiris in the same manner as in the plains, by raising on seed beds, later transplanting in main plot and training the plants on props.

Pepper, Capsicum (*Capsicum frutescens*, Linn.) Solanaceae.

We deal here not with the ordinary "hot" chillies of the plains in India, but with the exotic types used as vegetable and grown on the hills of Nilgiris. Of the latter, the *Bell* or *Sweet Peppers* are worthy of attention. They are of large size, usually mild in flavour and have thick walls. They can be grown in much the same way as brinjals (egg plants) are grown.

Celery (*Apium graveolens*, Linn.) Umbelliferae.

Celery is a good appetiser at the table and is used also in flavouring soups and dressings. It is a biennial, and forms a fleshy root and clump of compound leaves with long leaf stalks. These long leaf-stalks are used as vegetable. They are large and succulent; and they are blanched during the process of cultivation, which reduces the acrid flavour which otherwise is present, and causes the tender inner stalks to elongate rapidly adding to the quality of the crop. The usual way of blanching on the hills is earthing up as the plants grow. There are however other methods such as with brown paper, boards or old news papers. Plants are raised first in seedbeds and then transplanted in main plot. Harvest should be done soon after the blanching process is over to avoid development of diseases.

Leek (*Allium Porrum*, Linn.) Liliaceae.

It is a biennial plant, but is grown as an annual. Its blanched stems and leaves are used as vegetable. Seeds are first sown in seed beds and transplanted in the main plot and general methods of cultivation are almost like those of onion. Blanching is done by banking the plants with soil to a height of about 6 inches. When the banked portions are well blanched, they are ready for use.

True bulbs are not formed in leek, but the bases of the plants are slightly swollen, giving them almost the same appearance as green or bunch onions.

Globe Artichoke (*Cynara Scolymus*, Linn.) Compositae.

It is a herbaceous perennial plant. The flower stalks of the plant terminate in globular inflorescences with numerous subtending involucral bracts. The edible parts are those bracts and the soft fleshy lower ends of receptacles of the flower heads. They are either eaten raw, or more usually served with butter or sauce. It is best grown by vegetative propagation by means of suckers or offshoots.

Rhubarb (*Rheum Rhaponticum*, Linn.) Polygonaceae.

The large, thick leafstalks or petioles of rhubarb are used for sauces and pies, and can also be mixed with fruits to add flavour and tartness to conserves. Rhubarb is a perennial and is best propagated by root divisions. One large plant, three years or more old, gives by division three to six individual smaller plants. Rhubarb should not be allowed to seed; all seedstalks should be cut off as soon as they appear. Harvesting should be done by pulling, not cutting the leafstalks. The first harvest is done about two years after planting.

RESEARCH ON ENGLISH VEGETABLES

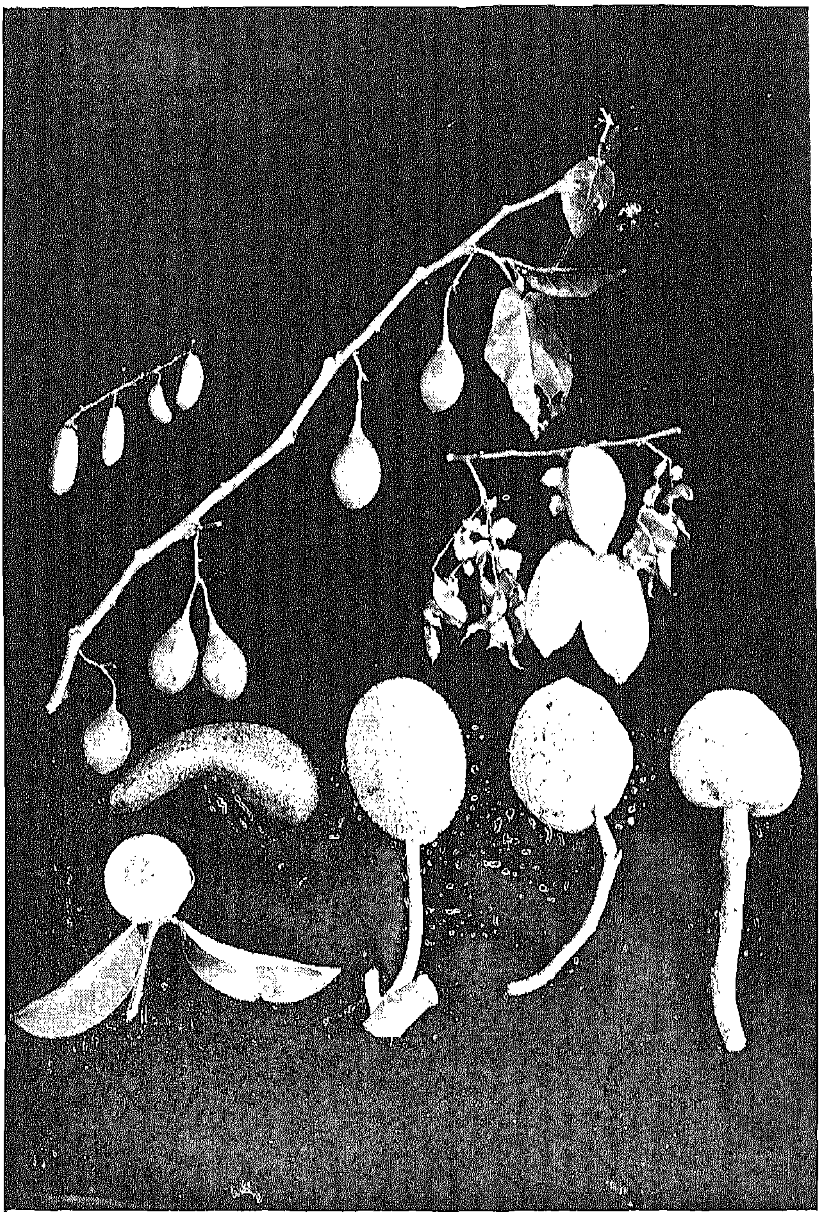
Most of the vegetables, with which this article has dealt, were introduced into the Nilgiris more than a century ago, and have established their foothold as economically profitable crops, and have also given a reputation to the district, all over the Madras State and elsewhere in India and Ceylon, for their quality. The credit goes mostly to the pioneers of the last century, who persevered in their efforts to make a success of vegetables alien to the region, and adapt practices of cultivation in the hilly areas, to suit an entirely different environment. In this, the Government Botanic Gardens, Ootacamund, played a notable part, and its sister institution the Pomological Station, Coonoor, subsequently, and still later, the Agricultural Research Station, Wellington. It is however a matter for surprise that inspite of more than a hundred years which have elapsed since their introduction, no sustained systematic research of acceptable standards has been conducted on these vegetables, to tackle the many problems which have naturally arisen with the growth of the vegetable industry. When a research station at Wellington came into being as a war baby mainly for the production of seeds of the temperate vegetables, some hope was however entertained of its expansion, to cover the several aspects of research on the exotic vegetables, to the benefit of

not only the Nilgiris, but to that of the several hill zones in India, similarly situated as the Nilgiris. But this station was closed in 1949.

Till the import of foreign seeds continued, the growers had a choice of the finest quality seeds from well recognized foreign sources, but with the severe restriction in imports, the growers have been left to fend for themselves, with the result that mediocre varieties, or varieties not true to type have been largely introduced into the Nilgiris, and the reputation for that quality of "English" vegetables for which the Nilgiris have been so long noted, is fast losing ground. Sporadic attempts have been made by the Government Agricultural Stations situated on the Nilgiris, in tackling the problem of production of seeds; but due to lack of co-ordination of efforts and lack of adequate scientific personnel to devote whole time to problems connected with vegetable research, no concrete results worthy of attention by the general growers of the Nilgiris have been achieved. The factors related to seed production of particularly the temperate vegetables are many. The optimun climatic requirements are among the most important. While many kinds of vegetables such as lettuce, tomato, peas and beans reproduce without a rest or dormant period and are considered as annuals, other vegetables such as cabbage, cauliflower, beet must enter a period of dormancy or rest for several weeks or months before reproduction or "seeding" occurs, and these vegetables are classed as biennials from the seed production point of view. The rest period is broken by low temperature or "chilling", just as in the case of the deciduous temperate fruits such as the apple. It is not the question of chilling alone; there is another important aspect of climate related to reproduction; that is the photoperiod or day length. Some kinds go to seed only under a short day, others under a long day, and the rest insensitive to day length. Generally speaking, day length must be combined with the essential chilling period before *economic* yields of seeds of many of these exotic vegetables may be expected. The Nilgiri Hills have favourable conditions of different elevations, with varying temperatures and photoperiod, and systematic investigations are needed to choose the zones best suited to

requirements of the individual varieties. Production of seeds of proper quality and adequate quantity can only be achieved by concentrating the work at places where there is assured water supply, absence of high winds, and where there is possibility of isolating fields which is one of the most important aspects of seed production, particularly in the cruciferous vegetables. Even a few accidental crosses in a field meant for production of a particular strain can spoil years of work.

Besides the problem of good quality seed, there are other problems in which the growers require guidance particularly with regard to correct agronomic practices, fertilizer requirements, control of insect pests and diseases, soil conservation and marketing. There are signs that the Nilgiri District will rise from its past neglect and reach a high level of prosperity as an international resort to which are likely to come, in large numbers, the people of the West to whom the temperate vegetables form the daily need. Besides this, the market at home, inside the country, in zones easily accessible to the Nilgiris, is expansive in its scope and can take what the Nilgiris can give. Let us hope that good days are ahead for the vegetable industry of the Nilgiris, and that the Government, growers and the public of Nilgiris will co-operate, to expand a worthwhile horticultural industry.



Left to right: Top row: Bilimbi, tree tomato and carambola.
Middle row: Avocado, bread fruit, cherimoyer, bull's heart.
Bottom left: Mangosteen.

8. FRUITS OF THE NILGIRI HILLS
(EXCLUDING CITRUS)

Many of the fruits for which the Nilgiri hills have justly become famous, ranging from the mangosteen at the lower elevations of the hills to pears and strawberry at the higher elevations were introductions from abroad. In the case of fruits of the temperate region like apples, plums, peaches and pears, the Government Botanic Gardens at Ootacamund did yeoman service in introduction, testing, establishment and expansion of several varieties even in the very early years of the establishment of the Gardens. To-day, the most popular and commercially successful among the temperate fruits is the pear and it is on record that it was W. G. McIvor from the Kew gardens, the first Superintendent of Government Botanic Gardens, Ootacamund, who, immediately after he came to Ootacamund in 1848, imported from England a large number of fruit varieties among which were good dessert varieties of pears, which he propagated on a large scale. In 1855, McIvor opened a small branch garden of 5 acres just above the Kalhatti Falls on the Sigur Ghat for the cultivation of fruits, and by 1859, had in all 178 species and varieties and he claimed, that he "possessed the most extensive stock of such fruits in all India". They included apples, pears, plums, peaches, figs, mulberries, raspberries, nectarines, apricots, vines, filberts, currants, strawberries. In 1887, it was sold by public auction. Considering the potentialities of the different elevations for different kinds of fruits from the tropical to the temperate, a fruit station under the Curator, Government Botanic Gardens, Ootacamund was established in 1871 at Burliar at an elevation of about 2500 feet, where a great number of exotic tropical and subtropical fruit varieties were subsequently introduced; in 1900, a second fruit station was established at a still lower elevation of 1400 feet, for introducing fruits suitable for the lower slopes of the hills; and in 1920, a third station at the higher slopes of 5600 to 5900 feet at Coonoor, (the Pomological Station), for dealing with temperate fruits such as the apples, plums, pears,

etc. Upto 1941, for nearly 93 years, the arduous task of pioneering in new introductions, their careful nursing and establishment in their new environments, fell on the staff of the Curator, Government Botanic Gardens, Ootacamund and a tribute is due to them for the able manner in which they brought to the Nilgiris, successfully in most cases not only the various common temperate fruits like the apples, plums, pears and strawberries but also such delicious, exotic, (and in some cases, difficult-to-grow) tropical and sub-tropical fruits as mangosteen, litchi, rambutan, durian, avocado, and a host of other fruits which in their comprehensive collection as they exist at the Government Hill Fruit Stations of the Nilgiris are perhaps unsurpassed and could be the pride of any fruit station in the world.

In paying tribute to the pioneers in the early days of fruit introductions on the Nilgiris, special mention should be made of men like George Oaks who made trials of numerous fruits at his estate, Downham, near Kalhatti, Charles Gray who was making similar trials at his place Orchardene near Coonoor, John Davidson, a gardener trained at Kew, also at Coonoor, and E. B. Thomas, Collector of Coimbatore and Nilgiris (1851–58) who had already established in the Burliar Garden by 1857, a number of tropical and subtropical fruit trees and plants, under the technical guidance of the staff of Government Botanic Gardens, Ootacamund, 14 years prior to its purchase by the Government in 1870.

In 1942, the hill fruit stations came under the care of Dr. K. C. Naik, the first Fruit Specialist to the Government of Madras. As an experienced and systematic horticulturist trained abroad, he built up the next logical phase of isolating high yielding trees, strains and varieties, trying different methods of propagation of these for subsequent multiplication and expansion, and experimenting with different horticultural practices to suit the growing of these exotics in their new environments on an expanded scale. Ever since 1942, these broad lines of work have been under way and the work of introduction of new knds and varieties of fruits has also been continued.

A knowledge of the climatic conditions as observed at the Kallar Fruit Station at an elevation of 1400 feet, (the lower

hill slopes), at the Burliar Fruit Station at an elevation of 2500 feet (below the middle range of the hills), and at the Pomological Station, Coonoor, at an elevation of 5900 feet (the higher range of the hills), gives an idea to some extent of the range of the climatic conditions on the Nilgiri hills in which fruits are being grown. Kallar has a climate more or less characteristic of humid tropics, has an average annual rainfall of about 55 inches, ranging from about 40 inches to 85 inches, with half the rains in the North East monsoon (October to December), and the rest distributed over the South West monsoon (June to December) and the hot weather (March to June). The temperature at Kallar ranges between 60° and 100° F. Burliar has higher average rainfall of nearly 60 inches, ranging from about 45 inches to 80 inches, with the distribution quite similar to that mentioned for Kallar and has higher humidity and lower temperature than Kallar. Coonoor has more or less the same range of rainfall and distribution as at Burliar, but the mean temperature still gets lower, usually ranging between 30° F and 95° F. At Coonoor, in December and January, for not more than six days in any year, ground frost occurs. These observations are enough to indicate that even the higher zones such as around Coonoor do not come anywhere near the climatic conditions particularly with regard to temperature, specially of winter, as seen in temperate countries where the deciduous fruits such as the apple, pear, peach, and plum, have come up to their best under long winter chilling conditions with snowfall being a characteristic and temperatures falling several degrees below zero degree Farenheit. The range of climate in all the zones of the Nilgiris where fruit-growing is being practised is suitable for a large number of tropical and subtropical fruits, rather than for several temperate fruits. But yet, the temperate fruits, such as the apple, the plum, the pear, the peach and strawberry have adjusted themselves to some extent to the subtropical conditions under which they are grown on the Nilgiris, but do not however reach even to a reasonable degree judged by standards of the West, either the tree size in the case of tree fruits, or the yields. The author has however had opportunities of working out the economics of these fruits

as grown at Coonoor and finds that even under such handicaps mentioned above, growing of these particularly the pear, plum, and peach is still profitable, due among other things to lower labour costs and to possibilities of having a larger number of trees per acre to compensate the lower yields.

Notes are given below about the individual fruits of the Nilgiri Hills. The author has had the background of a systematic study of sub-tropical fruits at the University of California at Los Angeles and of the temperate fruits at Michigan State College and the opportunity of travelling widely in the Southern States of U. S. A. particularly Florida where in such research stations as Orlando and Homestead, much valuable work is being done on the tropical and sub-tropical fruits, and in the Mid-Western and Eastern States of U. S. A. noted for temperate fruits. The author has also been for a while in charge of the Fruit Research stations on the Hills and has gone through in addition all the available Madras Government reports and bulletins, and above all the valuable book "South Indian Fruits and Their Culture" by Dr. K. C. Naik. But with all this, limitation of space does not permit more than very brief notes on these hill fruits. However, a few botanical and systematic horticultural notes here and there, have been introduced to stimulate further interest in a greater study of these aspects, because many of these fruits are out of the ordinary, and because the botany and horticulture of many of them offer still a wide field for research. Besides all this, fundamentally, if the plants are not understood botanically, one cannot work on them to satisfaction horticulturally. The list of fruits dealt with is not exhaustive, because citrus has been omitted for treatment separately elsewhere and such fruits as bananas, sapotas, pineapples have also not been dealt with, as either these are not peculiar to this zone alone or information is easily available on these through many sources. All these fruits dealt with in the notes have been successfully grown on the Nilgiris and are recommended to the residents, farmers and planters of the Nilgiris. Too many cultural details have not been possible but sufficient indications are given to enable growers to choose their preferences. The author appeals to the

planters of the Nilgiris, who are in all elevations of the hills, not to deny themselves the opportunity of growing the fruits suitable to their zones and providing for themselves and to their employees the necessary subsidiary food.

For convenience, the fruits are arranged alphabetically, according to the botanic names in preference to common names which frequently lead to confusion on account of their multiplicity. One other way would be to arrange them according to their importance, but most of these fruits are yet to establish themselves on a commercial orchard scale. However the readers' attention is invited to the fact that the mangosteen, annonas, jack, breadfruit, tree tomato, strawberry, apple, pear, peach and plum, come to the markets as products of Nilgiris, and therefore have a greater importance.

TROPICAL AND SUB-TROPICAL FRUITS

1. **Annona** spp. (*Annonaceae*)

The fruit of the Annonaceous group is a compound fruit (syncarpium), an aggregate of numerous closely crowded berries.

There are four species under cultivation on the Nilgiris, viz., (i) *Annona Cherimola*, (ii) *A. muricata*, (iii) *A. reticulata*, (iv) *A squamosa*. The last three of them are grown on the lower hill slopes, below 3,000 feet and the other in a wider range of elevations upto 7,000 feet.

(i) *Annona Cherimola*, Mill. Cherimoyer. Cherimoya. It is considered one of the fine fruits of the world and as far as Nilgiris is concerned, is the only annona successful on higher elevations. Very successfully cultivated in Southern California, there it has at least fifteen commercial horticultural varieties including Whaley, Deliciosa, Sallman, Bays, Macpherson, Booth, Pyerson, Carter, Chafey and Ott, and the varieties are horticulturally classified on the basis of mainly the surface characters of the fruits as finger printed (impressa), smooth (laevis), tuberculate (tuberculata), mamillate (mamillata), and umbonate (umbonata). Limited in its varieties, the Coonoor zone will benefit by introduction of varieties from Southern California.

It is said to have been introduced into the Nilgiris, first by a European, Clements Markham and planted at the Kalhatti Garden, but the trees died. Again in 1890, this was introduced into Nilgiris by A. C. Nicholson from Yercaud where previously Surgeon General Shortt had introduced it from South America.

It is generally propagated by seed and at the hill fruit stations of the Nilgiris, inarching on other annonas under different elevations has been in progress. At higher elevations, above 5,000 feet, bull's heart and custard apple do not seem to have been suitable as rootstocks. *Annona palustris* seems to be promising in this respect.

The cherimoyer exhibits dichogamy and the flowers are protogynous, pistils being receptive before the pollen is shed. Consequently yields are usually low. Hand pollination in Southern California has improved the yields, and is worthy of being tried in the Nilgiris.

Cherimoyer fruits are available in December – January and about 100 fruits per tree per year may be considered fair.

(ii) *Annona muricata*, Linn. Sour sop. Mulluseetha. Guanabana. The fruit is larger than that of the other annonas, dark green in colour, with the surface fairly outlined in rhomboidal areas, representing the numerous fused carpels, with a soft recurved spine in the centre of each. The flesh is white and juicy, but rather too acid for a dessert fruit and hence is mostly useful in making refreshing drinks.

It does not thrive so well in elevations as in the plains.

Propagation is usually by seeds. In Florida, budding and grafting are practised for propagation, splice grafting, whip-grafting and cleft grafting being successful.

Fruits are available from June to August. Sour sop is noted for comparatively greater shy bearing.

(iii) *Annona reticulata*, Linn. Bull's heart. Ramphal. Jamaica apple. The fruit has a smooth surface, with faint lines marking out the carpels and a brown or reddish yellow colour at maturity. The fruit is inferior to the custard apple in quality.

It is propagated by seed, and inarching is possible on other annonas. In Florida it is known to make a vigorous stock for other annonas, and in the Kallar Fruit Station, trial of bull's heart as root stock for the other three annonas is in progress.

Bull's heart commences maturing fruits in the middle of cold weather (January) and continues so till May, yielding annually upto 100 fruits per tree.

(iv) *Annona squamosa*, Linn. Custard apple. Seethaphal. Sugar apple. Sweet sop. In this species, the carpels of the fruit are quite distinct and easily separated, unlike in the other species where they are fused together to a greater extent.

Propagation by seed is the general rule. Inarching trials are in progress at the Fruit Research Station, Kallar on different root stocks viz., custard apple, bull's heart, sour sop and another allied species, *A. palustris*. Inarching on bull's heart at Kallar has been found to induce unusual precocity in the graft.

The custard apple seedling comes to bearing in three to four years, giving an average annual yield of 60 to 80 pounds per tree between August and December.

2. **Artocarpus incisa**, Linn f. (*A. Communis*, Forst.) Breadfruit. *Moraceae.*

The tree is monoecious with both male and female flowers on the same tree, the former in catkins and the latter borne on spongy receptacles. The tree is very ornamental in appearance. The fruits resemble jack but are much smaller in size, 4 to 8 inches in diameter, green when unripe, turning brownish and yellow when ripe. The fruits are produced on the small branches of the tree on thick short stalks, single or in clusters of two or three. The unripe fruits are used as vegetable. The bread fruit grows on the humid hill slopes of the Nilgiris upto about 3,500 feet.

There are both seeded and seedless forms of bread-fruit, the latter being preferred.

The seeded varieties are propagated by seed, preferably soon after the seeds are collected. In the case of seedless varieties, while the root suckers can be used for multiplication, more rapid and controlled propagation is by root cutting, 6 to 8 inches long, ½ to 1 inch diameter, planted horizontally about ½ inch deep during the monsoon season, as observed at Burliar. Gooteeing, cincturing and inarching on seedlings are all under investigation at Burliar.

The trees begin to bear after six years of planting and yield over 50 pounds of fruits per year per tree, going upto 200 pounds.

3. **Artocarpus integrifolia,** Linn f. Jack. *Moraceae.*

On the Nilgiris, jack trees form a familiar sight on the hill slopes and are often grown amidst coffee plantations, at the lower elevations. Trees are however found upto about 5,000 feet elevation.

The trees are of large size and are not suitable for growing on an orchard scale. The trees are monoecious, bearing staminate and pistillate spikes on the same tree. "Botanically, the fruit is a multiple fruit formed of achenes sorrounded by fleshy perianths on a common receptacle." The immense sized fruits weighing sometimes even upto 80 pounds are borne only on the trunk or larger limbs.

No varieties are recognized, but the fruits are of two kinds, one with soft flesh and the other with crisp and hard flesh In recent years, selections of individual trees from various places in Madras State have been made, and their progenies are under investigation at the Burliar Fruit Station. "Singapore Jack" is a variety introduced by Mr. M. S. Sivaraman, I. C. S. the Director of Agriculture, Madras from Ceylon into Kallar and Burliar Fruit Stations, with a reputation of bearing in 18 to 24 months from planting and has borne fruits at Kallar in 42 months, while normally the common jack varieties take 7 to 10 years to bear. The fruits are of good dessort quality, with an average size of 15 to 20 pounds in weight.

The usual method of propagation is by seed. In Florida, it is reported that jacks are successfully propagated by cuttings. At the Kallar and Burliar Fruit Stations, inarching trials are in progress, on its own seedling, Rudrakshi (a small fruited type of jack), and on *Artocarpus hirsuta* (a semi-wild species of the west coast).

Fruits are harvested on the hill slopes from May to August. The yield per tree per year is said to range upto 350 pounds and there is great individual variation in yield.

4. **Averrhoa Bilimbi,** Linn. Bilimbi. Cucumber tree. *Oxalidacae.*

This fruit, a relative of carambola, is more cylindrical in shape than the carambola, five angled, two to four inches in length and is acidic or sour, and suitable for pickling.

Propagation and culture are similar to those of carmbola, notes on which follow.

5. **Averrhoa Carambola,** Linn. Carambola. *Oxalidaceae.*

The fruit is light golden yellow in colour, attractive in appearance, with a thin, smooth, translucent skin, ovoid in shape and has 3 to 5 prominent longitudinal ribs, with the cross section of the fruit distinctly

star-shaped. It has a watery pulp which may be acid or sweet according to the strain. Sweet variety of fruit can be eaten fresh but the sour one can be used for refreshing drinks, or as substitute for tamarind. The pulp of immature fruits is known to remove stains from linen. Carambola can thrive on the Nilgiris on the lower slopes upto 4,000 feet.

Propagation is usually by seeds. Layering and inarching on seedlings have given fair success at Kallar and Burliar. Inarched grafts have shown extreme precocity, bearing within 10 months of planting compared to 5 years in the case of seedlings. In Florida, shield budding is reported to be successful.

Fruits are obtained throughout the year, attaining peak yields in January-February and September-October. Annual yields per tree range between 100 and 250 pounds.

6. **Chrysophyllum Cainito,** Linn. Star Apple. Cainito. *Sapotaceae.*

It is native to tropical America. It is an ornamental tree, with leaves of striking appearance. The fruit is shaped like an apple, 2 to 4 inches in diameter and smooth. The pulp is whitish and soft, sweet when mature. The transverse section is star-shaped. The colour of the skin is either green or purple. On the Nilgiris, star apple can thrive upto 3,500 feet. Fruits are obtained in February and March. The yield is about 150 pounds per year per tree. Propagation is by seeds, requiring 6 weeks for germination. In Florida, budding has been feasible.

7. **Cyphomandra betacea,** Sendt. Tree Tomato. *Solanaceae.*

It is a native of Peru, well established on the hills of Nilgiris, particularly in home gardens and is popular with the residents of Nilgiris. The trees are found on these hills to thrive from 2,500 feet upwards to 6,000 feet.

It is a small tree about 10 feet high, but a prolific bearer. It produces characteristically egg shapped fruits (berries) of purplish colour with pointed ends and smooth skin hanging in clusters near the ends of young shoots. The pulp is light orange in colour, with black seeds. The fruits are sub-acid in taste and are best used for jam making. The tree tomato is usually propagated by seed but can also be propagated by cuttings. The trees begin to bear normally in 1½ to 2 years after planting and do not seem to bear for longer than about ten years. Fruits are available almost throughout the year, with a peak in April to Sepember, and the yield per tree per year is about 40 pounds.

8. **Diospyros Kaki,** Linn f. Persimmon. *Ebenaceae.*

This is a native of China, and has also been cultivated in Japan for centuries. It is a deciduous, sub-tropical tree moderately resistant to winter cold, but not very resistant to high summer heat. It is a small to medium sized tree, with fairly rough bark, large, ovate to elliptic leaves, with flowers produced on current season's growth, usually dioecious, unisexual and sometimes monoecious, the pistillate flowers being solitary, axillary and the staminate flowers in 3 - flowered cymes. Based on flowering characters of the tree, the varieties have been classified into five viz: (1) pistillate, which is the most common condition, (2) pistillate but sporadically monoecious, (3) monoecious with both pistillate and staminate flowers in the same plant, (4) monoecious, sporadically staminate and pistillate, (5) staminate.

The fruit is a juicy berry with persistent calyx, generally eight-celled, with varying shapes, round to conical, small to large, yellow to red, soft to hard, *puckery or astringent on account of tannin* which disappears on the fruits softening.

Most varieties of Japanese persimmon are known to set fruit without pollination, parthenocarpically, thus being seedless. Where pollination occurs, it alters, in some varieties, the fruit characters, particularly darkening the flesh around each seed or darkening all the flesh in the *seedy fruit*. It may alter the flavour also. The varieties which are so affected are called *pollination variants* and those which are not affected *pollination constants.*

Persimmon has been thriving very well at Coonoor zone, (5,500—6,000 feet). It has for a long time been grown at the Pomological Station, Coonoor. It is one of those fruits for which taste has to be cultivated, but those who have been used to it, consider it among the most delicious fruits.

Other species of Diospyros, *D. virginiana* (American persimmon), *D. Lotus* (lotus persimmon or date plum), and *D. mollis* have been introduced into the Nilgiris, but they have been under investigation for rootstock possibilities rather than for any commercial value as edible fruits. Of named varieties, Dai Dai Maru, which was originally imported from Japan is important at Coonoor and is attractively orange red in colour, and medium in size. Hyakumi, a variety performing well in Southern California and Tananeshi in Florida do not seem to have been very successful at Coonoor.

Only in recent years, regular attempts have been made to propagate persimmon, and these have been on rootstock seedlings of *D. virginiana*, *D. Lotus*, *D. mollis* and rootsuckers of Japanese persimmon. The trials are being pursued at Coonoor. Some success has been obtained by inarching on *D. Lotus* and rootsuckers of Japanese persimmon. *D. chloroxylon*, *D. tomentosa*, *D. Ebenum*, *D. melanoxylon* are all species in South Indian forests and these have also been contemplated for rootstock purposes.

At Coonoor, the persimmons begin to bear in about 5 years after planting, flower in February, the fruits ripening in October. The fruits are harvested leaving a short piece of stalk attached to the fruit. Upto 50 pounds of fruit per tree per year can be harvested. To cure the fruits properly and make them ripen fairly rapidly, the practice evolved at Coonoor is to store the persimmon fruits along with mature Keiffer pears in closed chamber. The fruits are thus cured within three days.

9. **Durio zibethinus**, Linn. Durian. Civet fruit. *Bombacaceae.*

The durian is a tall tree 80 to 100 feet high, indigenous to Malaya with fruit of the shape of jack but smaller in size, very spiny on the surface, with large seeds and carpels surrounded by firm, cream coloured edible pulp. The ripe fruits have strong offensive odour but are considered most delicious by Malaysians who are used to them. The seeds are edible, and unripe fruit can be boiled as vegetable.

The old trees in Burliar had their origin in introduction from Paradeniya in Ceylon. Fruits when ripe drop from the tall tree and they are collected for use.

The propagation is by seed. Burliar Fruit Station records a fair success in inarching on its own seedlings.

Trees come to bearing after 11 or 12 years, producing from June to September, about 50 fruits per tree per year.

10. **Eugenia Jambos**, Linn. Rose-apple. *Myrtaceae.*

Rose-apple is said to be native of India and Malaya. It is a large, handsome, spreading tree, reaching a height of 30 feet or more and an equal spread. The new flush of growth is wine-coloured. Flowers are large, greenish white, and showy with numerous long stamens. Fruits have almost spherical shape, 1½ to 2 inches diameter, pale yellow to pinkish white colour, a crisp flesh with the odour and flavour of rose, but the fruit is almost tasteless, and the rose water flavour is the only attraction. It is better used as a candied fruit or for jellies.

Propagation is by seeds which exhibit polyembryony with two or more plants coming from a seed. Layering is also successful.

11. **Eugenia uniflora**, Linn. Surinam cherry. Pitanga. Brazil cherry. *Myrtaceae.*

This is indigenous to Brazil. On the Nilgiris, it grows both on the lower and higher elevations, from about 1,500 upto 5,500 feet. It can resist cold better than other Eugenias.

It is an ornamental shrub which can be used also as a good hedge. The new growth is wine-coloured as in most other Eugenias. The fruits are sub-globose, hang in clusters on thin stems, not more than an inch in diameter, 8-ribbed and very thin skinned. The pulp is soft, juicy, pleasantly acidic and aromatic, imbedding a large round seed. It can be eaten fresh; or jellies and sherbets can be made with it preferably. A yield of 6 to 8 pounds per year per plant can be obtained.

Propagation is by seed, which germinates in about 3 to 4 weeks. Cleft grafting is also practised in Florida.

12. **Feijoa Sellowiana**, Berg. Feijoa. Pineapple guava. *Myrtaceae.*

It is a South American sub-tropical plant, ornamental and shrubby, with leaves characteristically glossy green on the surface and silvery grey beneath. The flowers are striking in appearance and have four, white, thick edible petals with purplish tinge on the inner side and white outside and a tuft of crimson stamens. The fruit is a berry, having oblong to round shape, and gray green colour and persistent calyx lobes. It has a good flavour. It is suitable for higher elevations. It is known to resist low temperatures of even 12 to 15 degrees Farenheit, in observations elsewhere.

The plants come to bearing in the fourth year after planting. Fruits fall to the ground when they are ripe. They are obtained in September to December. Some varieties are self-sterile. In the case of feijoa, the most feasible method in solving pollination problems is to grow two or three different seedlings in a group, which in Southern California has helped fruit-set. The choice of variety in this connection is also important. For example, in Southern California, the variety Choiciana requires cross pollination, and given this, it produces fine quality fruits about 3 inches long; on the other hand, the variety Coolidge is fairly self fertile and can be grown by itself without pollenizers. Superba is another variety which gives regular crop when provision is given for cross pollination. These varieties are worth introduction and trial on the Nilgiris.

Propagation is mainly by seed. Germination takes 2 or 3 weeks. Cuttings and layers as tried in Florida are very slow. Grafting on seedling stock for choice varieties is done in Florida.

13. **Garcinia Mangostana,** Linn.. Mangosteen. *Guttiferae.*

Mangosteen ranks among the most delicious fruits known to man. But because of its most exacting requirements with regard to climate, soil and utmost care of plants from the very initial stages, and because of very slow growth and long pre-bearing stage (nearly ten years), there are very few commercial sized orchards in the world. India has an estimated area of about 25 acres of mangosteen, all of which are in South India, on the lower slopes of the Nilgiris, and near Courtallam in Tinnevelly District. The Kallar and Burliar Fruit Stations with more than 200 bearing trees may perhaps be considered to have one of the large mangosteen orchards in any country. The other countries which grow mangosteen are Indonesia, Cochin-China, Malay States and Ceylon. West Indies and Hawaii have also recently come into the field.

Mangosteen is an ever green ornamental tree 25 to 30 feet high with large leathery thick dark green leaves, glabrous and glossy, polygamo-monoecious, with perfect and imperfect flowers in the same tree. The hermaphrodite flowers have four, thick, persistent, orbicular sepals, four broadly ovate pinkish fleshly petals and a superior ovary producing purple red round fruit with smooth thick rind, enclosing 4 to 8 white edible segments, which may or may not contain seed. A more thorough and systematic investigation of the root-development, floral morphology, sex situation, and blossom biology of the mangosteen at Kallar and Burliar, than has been possible will be worthwhile and fruitful.

Propagation by seed has been the only practical method of propagation. The Kallar and Burliar Fruit Research Stations have experimented actively for more than a decade with several possible methods of propagation and have included in them the use of rootstocks of *Garcinia tinctoria, G. cambojia, G. indica and Calophyllum inophyllum,* but no concrete results have been yet obtained. Polyembryony to the extent of about 5·5 per cent in mangosteen has been found at Kallar.

Among the requirements in successful establishment of mangosteen in South India are firstly the optimum climate such as is found at Kallar and Burliar, (1200 ft. to 3500 ft.), with an annual rainfall of about 50 inches and more, well sheltered site, fertile retentive soil, care in sowing seeds within a few days of their extraction from fruits, care in transplanting because of the long tap roots and poor lateral root development, and providing shade for the young plants.

The trees begin to bear after 10 years or more and yield ordinarily two crops in a year, once in January to March and again between July and October, altogether amounting to an average of 400 fruits per tree per year. Yields upto 800 fruits per tree have also been recorded.

The trees continue to bear for decades and trees of 80 years old are known to be still continuing to carry good crops at Burliar.

The trees often suffer from a disorder, gambog, said to be of a physiological nature, with excrescence of gum on the fruits, mostly those exposed to direct sun. Leaf deformities are also found to occur and they are conjectured to be due to some nutritional deficiency. Some leaf eating caterpillars are also recorded.

There are no horticultural varieties.

The fruits stand long transport and storage, extending to two to three weeks because of the thick pericarp.

This precious fruit is worthy of greater expansion, and planters in the mangosteen zone would be well advised to co-operate in the extension of area under this fruit wherever possible, for this delicious fruit is bound to be highly profitable in the long run.

14. **Lansium domesticum,** Jack. Langsat. *Meliaceæ*

It is Malayan in origin. Langsat fruits are one to two inches in diameter, oval or round, with leathery pubsecent skin which does not adhere to the flesh, straw coloured, juicy and aromatic and have translucent flesh and bitter seeds contained in five or less distinct segments. To some extent they resemble loquat in general appearance.

The trees are being propagated by seed. No other method of propagation has been attempted at Nilgiris.

The fruits are harvested in April to September. 30 pounds of fruits per tree per year on the average are produced at Burliar.

15. **Litchi chinensis,** Sonn. (*Nephelium litchi,* Camb.) Litchi. *Sapindaceæ*

Litchi is a handsome tree, with deep, glossy green foliage, new growths being orange coloured. The fruits are oval in shape, about 1 to 1½ inches long, with bright red, tough, brittle skin, divided into small shield-like scales. The pulp is glistening white, firm and juicy and encloses a single large brown seed, which is sometimes shrunken. This fruit is a very delicious fruit and very popular in Northern India. Litchi is noted to be polygamo-dioecious; and often, shy bearing or no bearing is related to this floral situation.

The trees thrive well upto an elevation of 3500 feet. Kallar Fruit Research Station has introduced 11 years ago from Calcutta in 1942, six varieties Bedana, Deshi, Calcutta, Dinpur, Purbi and Rose Scented, and are under trial. There are older trees of litchi however, bearing fairly good yields at Kallar and Burliar.

Litchi is usually propagated by layering and gootee. Inarching is possible on litchi seedlings or those of longans (*Euphoria longana*). An American method of rooting of cuttings of litchi reported to be successful is to plant the cutting in a medium of sand and muck mixture in such a way that the base of the cutting just comes in contact with the rooting medium, by tying the cutting to the pot label.

Litchi commences bearing about six years after planting. Fruits are obtained in April and May at Kallar and Burliar. Yields of individual trees have ranged from about 90 to 290 pounds. Litchies are preferably harvested in clusters with a portion of stalk and leaves retained, to store the fruits for a longer period.

Litchi fruits are also dried and then they are called "litchi nuts".

16. **Monstera deliciosa,** Liebm. Monstera. *Araceae.*

This is Mexican in Origin. It is an attractive, ornamental, vigorous scrambling climber, with large, broad, long petioled, incised leathory leaves, clinging to its support by heavy aerial roots. In the flowers, a

waxy white spathe encloses a green spadix, from which develops large fruit in the shape of an ear of maize but larger in size, which matures about 14 months or more after flowering. The fruits are edible and the soft pulp has a delicate "pine apple-banana odour" and a sweetish pleasant taste. When the fruits are fully mature, the green colour of the fruit turns to yellow, and the scales which cover the surface loosen and they subsequently fall off. When the fruit is cut, the stem is placed in a glass tumbler of water and when the lower scales fall, then the fruit is ready for eating. It ripens from the base upwards and not all simultaneously, and the fruit can thus be eaten, a portion at a time as it ripens, provided it can be stored properly, preferably in a refrigerator.

This is propagated by stem cuttings, with two or more segments or buds. Seeds are at times produced and can be used for propagation.

17. **Naphelium lappaceum**, Linn. Rambutan. *Sapindaceae.*

The rambutan is Malayan in origin. The fruit resembles litchi in character. Botanically, rambutan is distinguished from litchi, among other things, in that the latter has the seed covering or arillus free from seed as against the former having it grown to the seed. Crimson coloured spines cover the greenish or yellowish skin and the edible pulp (aril) is white or rose coloured, translucent and juicy It is a delicious fruit and considered by many as even more delicious than the litchi. It grows in the same climatic zone as litchi.

There are only a few trees in the Kallar Fruit Station but due to its fine quality of fruits, rambutan is worthy of further expansion.

Propagation can be done by seed, layering or inarching on the same seedling rootstock.

An average of 20 pounds per tree per year at Kallar is recorded to be borne from September to November.

18. **Passiflora edulis**, Sims. *Passifloraceae.* Passion fruit. Purple granadilla.

It is a vigorous climber requiring trellises or bowers which they cover rapidly. The leaves are three-lobed, though the juvenile leaves are not. The flowers are quite ornamental, solitary, borne on long stalk, and self-fertile. The tubular form of the flower provides for self-pollination. The mature fruit is oval, about 2 to 3 inches long, with a hard shell purple in colour, which contains inside sweet, aromatic, juicy pulp in which are imbedded numerous small seeds. The edible portion is the fleshy aril. The pulp can be eaten fresh; a little addition of sugar will enhance the taste. It goes very well in fruit salads. The fruit Biochemist of the Madras State has been producing very fine quality of passion fruit squash. It is so popular and the passion fruit vine is such a quick grower that there is scope in the immediate future for a profitable passion fruit squash industry on the Nilgiris.

The vines perform better at higher elevations around 5,000 feet.

Two varieties are recognised by horticulturists viz., (1) mammoth purple-fruited granadilla (Victoria) and (2) yellow fruited granadilla such as in Hawaiian Islands.

Propagation is by seed, which germinates in two to three weeks or by cuttings of mature wood, which are found to result in precocious plnats yielding within four months of planting.

Seedlings normally commence to bear in the second year of planting, reaching maximum yields in sixth year. Although the plants are in fruit almost throughout the year, the peak seasons are in May-June and September-October. Fruits are harvested, when well coloured (before they are too ripe and drop), with a portion of stalk attached to the fruit. 12 to 15 pounds per vine may be considered a fair estimate of annual yield. The fruits stand transport well, because of the hard shell.

19. **Persea drymifolia,** Cham. and Schlect. **and Persea americana,** Mill. Avocado. Alligator pear. Ahuacate. Aguacate. Avocat. Avocato. Abacate. Butter Fruit *Lauraceae.*

Avocado is considered one of the best of the semi-tropical fruits, and has become one of the most widely used fruits in the U. S. A.

Three horticultural races are recognized in avocado, viz., the Mexican, the Guatemalan, and West Indian. The first of these belongs to the species *P. drymifolia* distinctly characterised by strongly anise scented leaves, smallest sized berry of all the three races, with thin skin and high oil content. The other two races belong to the species *P. americana.* The West Indian race has the largest fruits of all the three races, with thick leathery skin, nearly always smooth, ripens earlier but has low oil content (7 to 10 per cent). The Guatemalan race is characterised by new growths being purple red, medium to large sized fruits with thick, brittle, rough and warty skin and medium oil content (10 to 20 per cent). In the 28 year old avocado industry of Southern California, the Mexican race is represented by such commercial varieties as Topatopa, Mexicola, Duke, Northrup and Blake; the Guatemalan race by Nabal, Hass, Anaheim, Dickinson and Itzama; and the West Indian race is not grown commercially in California. On the other hand, Florida specialises in the West Indian race which is more suitable for its more humid tropic climate and which is likely to be also the better suited for the Kallar and Burliar zones of the Nilgiris. The West Indian race is represented in Florida by commercial varieties such as Trapp, Pollock and Waldin. Besides these there are a number of varieties which do not exactly fall under any of these races and are thought to be hybrids between Guatemalan and Mexican e.g. Feurte of exceptional quality in California, Peubla and Lula in Florida.

Avocado thrives on the Nilgiris in the lower humid slopes upto 3,500 feet elevation. At Kallar and Burliar, fruits of *P. americana* seem to have been grown for a fairly long number of years. In 1949, Pollock, Feurte and Paradeniya Purple Hybrid varieties were introduced from Ceylon and are under investigation.

Avocado often exhibits dichogamy, with the anther and stigma maturing at different times. In the avocado, as observed in Southern California, the flowers open and close in unison twice, at intervals of 18 to 30 hours, depending on weather conditions. At the first opening, the pistils are receptive but the stamens do not shed pollen, but in the second opening, the pistils are not receptive but the pollens are shed. But weather conditions affect this process markedly, and generally there is sufficient overlapping and irregularity in this process to make fruit-set possible. Occasionally seedless fruits are found in avocado; they are called "cucs", and are not useful commercially.

Avocadoes on the Nilgiris are being propagated by seed usually. Kallar and Burliar have obtained good success in layering. Budding is successfully practised in other avocado growing countries.

At Kallar and Burliar, the trees flower in February–April, and ripe fruits are obtained in August–September. Flowering is also noticed in November–December, which results in fruits in May–June. 35 pounds of fruits per tree may be considered an average yield per year.

20. **Physalis peruviana**, Linn. Cape gooseberry. Peruvian cherry. *Solanaceae.*

It is a native of Peru and has established itself on the Nilgiri hills. It is suited to quite a good range of elevations, almost from the plains to 6,000 feet and is thriving very well around Coonoor, between 5,000 and 6,000 feet. The variety at Coonoor seems to have been introduced from South Africa.

It is a low herbaceous perennial, partially standing erect, attaining a height of 1½ to 3 feet, producing fruits (berries) resembling cherries in size and shape, enclosed completely by the dry enlarged leafy, persistent calyx. The fruit, particularly of the variety at Coonoor is very agreeably acidic and pleasantly flavoured and is well worth further expansion. A delicious jam can be made from the cape gooseberries.

The propagation is by seed. Seedlings when 6 to 8 inches high can be planted as inter crop in orchards or grown by themselves. Cutting and layering have also been shown to be possible at Coonoor for propagation.

The seedlings flower in the second year from sowing. Fruits are obtained at Coonoor mostly between January and May. Wide variations in yield of individual plants have been noted at Coonoor, ranging from 20 to nearly 230 fruits per plant. Well grown cape gooseberries are said to be capable of yielding more than 20,000 pounds per acre.

21. **Psidium Cattleianum**, Sabine. Cattley guava. Chinese guava. Strawberry guava. *Myrtaceae.*

This is native of Brazil, and more cold resistant than the common guava, and hence is suitable for the higher elevations of the Nilgiris.

An ornamental shrub, it produces fruits which are small and resemble the common guava. On the Nilgiris, it thrives between 2,500 and 5,500 feet. The fruits are preferably used for jellies. If grows without much care. Fruits are obtained in July August.

Two Botanical varieties of strawberry guava are recognised viz., (1) Var. Lucidum, a yellow fruited, roundish form, and (2) Var. Acre, a yellow fruited elongate form.

TEMPERATE FRUITS

1. **Fragaria spp.** Strawberry. *Potentilleæ*

Strawberry fruits have a brisk trade around Coonoor, Ootacamund, and Kotagiri, during the season (summer), on account of demand from the high class visitors to this pleasure resort and from the rich residents of the hills. Very good prices are obtained for the fruits and there are growers who specialise in producing this fruit to meet the demand. They are sold in attractive little baskets. On account of the perishable nature of the fruit however, it has not much scope for reaching the markets of the plains in sufficient quantities. It is grown more intensively in elevations between 5,000 and 7,000 feet.

It is a hardy, temperate low creeping perennial, with short thick stems close to ground and with runners which root, and produce fruits which are horticulturally aggregate and accessory, the receptacle being edible and carrying small achenes, the true botanical fruits. There are three major species of strawberry which are parents of the cultivated strawberries: 1. *Fragaria virginiana*, growing wild in North America with small plants and fruits, 2. *F. chiloensis* growing in the Pacific coast of the U. S. A. with fairly large plants and fruits, and 3. *F. vesca* a European species, with vigorous plants but small fruits. *Fragaria nilgerrensis* is a wild type of strawberry, indigenous to Nilgiris and its potentiality for breeding purposes is worth investigation.

Most good commercial varieties in U. S. A. are hybrids of the first two species. Among the well known varieties, there are Klondike, Oregon, Banner, Golden Dour, Schaster, Placer Among plants of strawberry occur interesting sex forms such as the pistillate only, requiring pollinators, and perfect flowers but with few stamens, hence also requiring outside pollen for proper fruiting.

Strawberries are propagated by runners or division of the crown (splits). Propagation trials at Coonoor indicate the greater usefulness of planting slips 'from three year old mother plants, which bear earlier and better than runners.

Planting of splits or runners is done in March or July–August in rows 2 feet apart, with spacing of about 9 inches to a foot in the rows. They may be planted also in somewhat closer rows in long beds, each bed having 2 or 3 rows, with a path running between two beds. Gaps arising subsequent to planting should be filled up promptly. Irrigation facilities are essential for proper establishment of the plants and maintenance of quality and size of fruits. Heavy manuring prior to planting, is also important. Manuring individual stools also seems to have given good results. Mulching with ferns or leaves between the rows in January or just after the commencement of flowering is good for conservation of moisture in summer and prevention of contact of fruits with the soils. Deblossoming when flowers appear too early and retention of not more than four runners in each stool, are among practices leading to better production of crop.

Plants flower from December to March and fruits are picked from February to July. Firm, well coloured fruits are collected every day or at least on alternate days with pieces of the stalks intact. Under Coonoor conditions, an average of 25 fruits per stool is considered fair. The crop is removed after two fruiting seasons. This is a crop on the Nilgiris almost free from any serious insect pests and diseases and worthy of further encouragement on the hills. In some seasons however, cockchafer grubs have been noticed doing injury.

2. **Prunus Persica,** Sieb and Zucc. Peach. *Prunæ.*

Peach is a warm temperate zone fruit with two horticultural races which are subtropical. The fruit buds are simple with usually one flower per bud, borne laterally on one year old shoots which consist of slender twigs. Flowers are fregrant, quite attractive, coming out relatively early. The fruit is a drupe with a hard mesocarp and hairy exocarp. Peach is usually self-fertile with exceptions where pollinators are necessary.

Peaches are classified into *clingstones* or *free stones* based on the adherence of stone to the flesh, the former usually having hard flesh, and the latter, soft and melting flesh. They are classified according to colour into white and yellow fleshed varieties. There are also canning, shipping and drying varieties. There are said to be five horticultural races, (1) the Spanish, (2) the Persian, (3) North China or Chinese Cling, (4) South China or Honey, (5) Peento or Saucer race, the last two being sub-tropical races. Honey, Climax, Pallas, Triana, Florida Gem, Taber and Peento are varieties which belong to the sub-tropical races, adapted to mild winters, and fairly intense summer. Babcock is a hybrid developed at California Experimental Station, adapted also to mild winters and fairly high summer. These varieties are likely to be suitable for Coonoor zone

Peach being one of the fruits adapted for warmer winters, particularly with a range of sub-tropical varieties available, peach deserves even better attention on the Nilgiris than it has hitherto received. At present, the peaches on the Nilgiris are being grown between 4,500 and 6,000 feet.

Of about 20 varieties tried at Pomological Station, Coonoor, only two are deemed suitable for commercial cultivation viz. Killikrankie and Shanghai Seedling, the former an early, yellow fleshed clingstone with small to medium sized fruits and Shanghai Seedling a late, yellow fleshed clingstone with large attractive fruits.

Peach is propagated by shield budding on common peach seedlings, in January–March. It is planted at Coonoor from July to January. It is trained to vase shape and in pruning bearing trees, growths are annually shortened to produce fruit-bearing new wood. This general method however should vary with needs of the varieties and individual trees.

A peach tree comes to bearing in about three years of planting. According to the varieties, time of flowering varies from November-December to March, Killikarankie flowering earlier in November-December, maturing fruits in May and Shanghai Seedling in March, maturing fruits in July. Upto 20 pounds of fruit per tree are produced per year on the Nilgiris. The commercial life of the peaches may not last longer than 20 years.

San Jose scale, *Icerya purchasii* and fruit flies are among the insect pests of peaches.

3. **Prunus salicina,** Lindl. Japanese plum. *Prunae.*

There are four different species of plums worth consideration in promology (1) The European plum, *Prunus domestica* commercially the most important in the West, (2) the Insititia plum, *P. insititia*, (3) the Myrobalan or cherry plum, *P. cerasifera* used extensively as rootstock, (4) the Japanese plum, *P. salicina*, very important in Japan and China.

We are here concerned however with the Japanese plum which is the only species of plum of some importance on the Nilgiris. In the Japanese plum, fruit buds are borne laterally on shoots. The fruits are drupes, tending to be heartshaped, yellow and red being the backgrounds of colour, quite attractive.

On the Nilgiris, these plums are grown in elevations between 5,000 and 6,000 feet. The plums are not as popular with the common man in this country as much as the apple or the pear. They do not also keep in

storage as well as an apple or a pear. But they are the most easily grown of stone fruits and are good bearers in their suitable zones in the Nilgiris.

Over 35 varieties have been under trial at the Pomological Station, Coonoor. Of these the Gaviota, Shiro, Abundance, Czar, Kelsey, Satsuma, Hale, Rubio, Satsuma Seedling and Alu Bokhara have been selected as the best. Of these Czar and Kelsey are found to be mainly self-sterile; Shiro, Gaviota and Abundance have also this problem but to a somewhat lesser degree. Hence these should not be planted either alone by themselves or together, but with proper pollenisers. Rubio, Satsuma Seedling, Alu Bokhara, Hale and Satsuma are known to be self-fertile. It is, however, important for proper pollination that varieties which flower at one time are planted together. At Coonoor, Rubio, Alu Bokhara, and Satsuma Seedling flower at the same time more or less, while Hale, Shiro, Abundance, Gaviota, Czar, Kelsey and Satsuma come under another group with flowering time coinciding.

The usual method of propagation of plums at Coonoor is by shield budding on one year old seedlings of a poor quality variety of peach, called the "Country" peach, which seems to have been originally introduced from Australia. However, some varieties, for example the Czar and Gaviota, do not show perfect union with this common or country peach. To overcome this defect in such combinations, other rootstocks such as *Prunus divaricarta* have also been under trial. The Myrobolan or cherry plum. the apricot etc. which have been in use elsewhere as rootstocks have not yet been attempted at Coonoor.

Plums are planted on the Nilgiris from July to January. Training and pruning depend on the varieties. An open centre seems to be the natural eventual shape for the trees. "Long" pruning wherein the minimum necessary for removal of diseased branches and thinning out over crowded growths seems to have worked out better at Coonoor. Pruning is done in February-March. Plums flower from December to March. Early varieties such as Satsuma Seedling and Rubio are harvested towards the end of April, midseason varieties such as Alu Bokhara, Gaviota and Hale in May, and late varieties such as Shiro, Czar, Satsuma and Abundance till June. Yields vary according to variety and season, going upto about 90 pounds per tree per year.

San Jose scale and fruit fly are among the major pests of plums.

4. **Pyrus communis,** Linn. Pear. *Pomae.*

Botanically the pear fruit is a pome like the apple. While there are certain botanical characters common to pear and apples there are also certain interesting features, which distinguish the pear from the apple. Apple has a shorter and sturdier trunk. Apple bark shreds in irregular scales as against checking of pear bark in near-squares; the flowers in apple are pink, red or rose and borne in fascicles, while the pear flowers are white and borne in corymbs. The ovary in apple is 3 to 5 celled while in the pear it is 5-celled. The styles are united at the base in apple but are free in pear. The apple fruit is oblate to round with distinct depressions at both ends, whereas the pear fruit is pyriform, sometimes subglobose and more often conical at the base. The pear fruit is noted for its grit cells (stone cells), which gives the pulp its characteristic texture, while the apple fruit has no grit cells.

Of all the temperat deciduous fruits, the pear is the most popular in South India and has the status of being grown in orchard scale on the Nilgiris, more extensively than the others. It is found in the markets all over South India and has almost established itself as a fruit for the common man, because of the taste that seems to suit the people, the cheaper price, and a better keeping quality than most other temperate fruits under South Indian conditions.

On the Nilgiris, pears thrive better in elevations between 5,500 and 7,000 feet. Among 20 varieties and more under trial in Pomological Station, Coonoor, the Keiffer alone has established itself as a suitable commercial variety. It is on record that this variety was originally introduced from Saharanpur. The Keiffer is reported to be a hybrid obtained by crossing the European pear *P. communis* with the Japanese pear *P. serotina.* Among the good commercial varieties of California, a high ranking state in pear growing, are Bartlett, Winter Nelis, Bosc and Comice, worthy perhaps of trial on the Nilgiris.

Pears are propagated on the Nilgiris by whip-and-tongue grafting on rooted cuttings of an inferior variety of pear which is in a semi wild state on the hills, called the *stock pear* or *country pear*. *Pyrus pashia* as a root-stock for pear has been under trial at Pomological Station, Coonoor.

The pears are planted mostly in January at Coonoor. The need for interplanting of varieties to overcome the defect of self-sterility in some varieties has been recognized. It is trained generally to a vase form and pruned annually in a similar way to apple, depending on the variety, in December-January. The trees commence bearing in 7 to 8 years after planting. The trees flower in January to March in Coonoor and fruits are obtained from May to September. Keiffer yields annually per tree on the average about 70 pounds and goes up to about 110 pounds.

San Jose scale is the major pest on pears.

5. **Pyrus malus,** Linn. (*Malus domestica,* Borkh). Apple. *Pome.*

Botanically, the fruit of the apple is a *pome* which is a spurious fruit in which the true fruit is imbedded in the succulent receptacle. However, the morphology of the fruit has been a controversial one between two schools of thought, one which adheres to the "*Receptacular theory*" according to which, by ontogenic observation, the fleshy part is the receptacle and the other school which adheres to the "*Appendicular theory*", according to which, the fleshy part consists of fused and enlarged bases of floral appendages (floral tube).

Apple is about the most important fruit of temperate regions but has been attempted to be grown under rather sub-tropical conditions of the Nilgiris in the elevations around 5,600 feet. What is even more interesting, apple is being grown in South India under even lower elevations of 3,000 feet in Bangalore, where for a long time by ingenious methods of culture two crops of apples have been harvested every year and where apple growing under such conditions has been made a fairly profitable proposition. But neither in Bangalore nor in the higher elevations of Nilgiris can the trees be said to be comparable in any respect, tree size or yield, to the apples in the temperate countries. But apple however is such a delicious fruit and the demand for it in the country is so keen that any reasonable success that can be achieved in economic production of good quality fruits will be worth the trouble. But the problems in the Nilgiris are similar but in an even more severe degree to those existing in the

southern states of the U. S. A. where due to lack of sufficient cold in the winter which is necessary for breaking the rest period of the apples, a large proportion of buds fail to open ultimate result being poor and irregular cropping. In line with the work done in parts of the West in the use of chemicals and dormant oil sprays to overcome this defect, a single dormant spray of three percent linseed oil emulsion at Coonoor has been tried and has given indications of success.

Nearly 30 varieties, most of them from Australia, have been under trial of which the following are recorded to have done best at Coonoor viz. among early varieties, Zouches Pippin, a dessert variety fairly immune to wooly aphis and Allsop's Early, a culinary variety also fairly immune to wooly aphis; among midseason varieties, Irish Peach, a dessert variety fairly immune to wooly aphis and a terminal bearer, Carrington a dessert variety with regular bearing habit, bearing on spurs and non-spurs equally and resistant to wooly aphis, Winterstein, a dessert variety, a pronounced non-spur bearer susceptible to wooly aphis, and Edward VII, a culinary variety bearing on spurs and susceptible to wooly aphis; among the late varieties Signe Tillisch, a dessert variety with good keeping quality, a spur bearer, resistant to wooly aphis, and Rome Beauty, another dessert variety with good keeping quality, mostly non-spur bearer, highly susceptible to wooly aphis.

In both the apples and pears, generally all degrees of self sterility and inter-sterility have been recorded by horticulturists. Some varieties are self-fertile. Some require specific pollinators. There is also some tendency towards parthenocarpy and there is evidence, though slight, of metaxenia (effect of pollen on the fruit). All these are factors to be reckoned with in judging the real merits of varieties. Moreover, it is seen that in comparable climates in U. S. A. where delayed foliation has been prevalent, much work has gone ahead in breeding varieties requiring less winter cold or "chilling". These results are of value to the research workers on the Nilgiris.

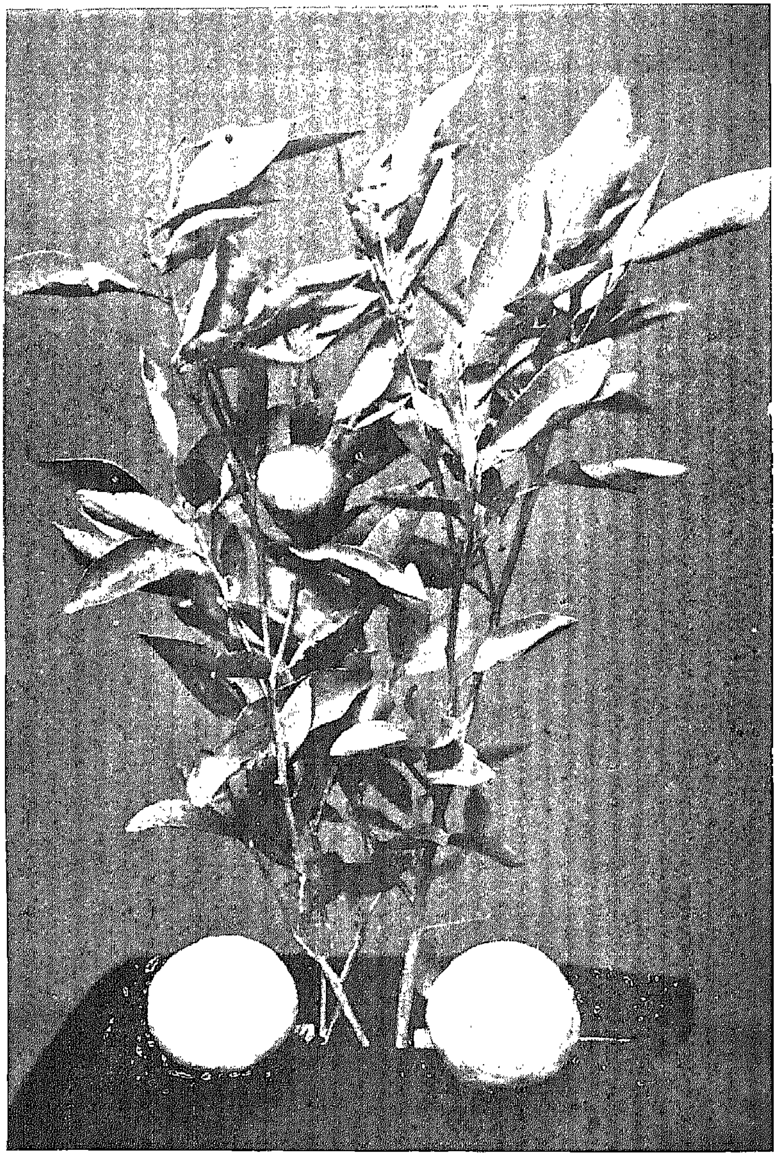
The general method of propagation of the apples on the Nilgiris is whip or whip and-tongue grafting preferably in December to March on rootsuckers of crab apple *(Pyrus baccata)*, stock trees of which have been also introduced and established from abroad. But the crab has been very susceptible to wooly aphis, and therefore for the last decade and more, to find a better substitute for a rootstock, several standard English clonal stocks from East Malling Research Station and from the John Innes Horticultural Station called the Mallings and Mertons respectively, have been under trial at the Pomological Station, Coonoor. The Merton stock Nos. 778, 779, 789 and 793 have proved to be the most useful, particularly 778 and 779, being both resistant to wooly aphis and more prolific in production of layers.

Apple trees are planted on the hills between July and January. They are trained at Coonoor to a modified leader system but cordons and espaliers are also under demonstration at Pomological Research Station, Coonoor and can be recommended for home gardens. The pruning of bearing trees at Coonoor is done in December-January, and in spur bearers, it consists in cutting back of long growths to encourage spurs. In non-spur bearers, pruning is done with a limited objective of thinning only excessive new growths so as to maintain continuously adequate number of new growths which produce flower buds in their second year. After pruning, spraying with lime (1 pound of freshly slaked quick lime to 10 gallons of water) is a good plant sanitation measure.

Apples flower at Coonoor in February March. Fruits are available from April to July, according to the varieties. Among the varieties tried at Coonoor, the Allsop's early gives an average annual yield of 24 pounds, Signe Tillisch and Winterstein 12 pounds, per tree. Upto 52 pounds yield per tree has been obtained.

Among insect pests other than wooly aphis from which the apples suffer at Coonoor, are the San Jose Scale *Aspidiotus perniciosus* which is very severe sometimes, the scale insect *Icercya purchasii*, and to a minor extent plant lice *Dilachrus Krishni*. Among the diseases are the mildew *(Oidium species)* on the leaves and shoots, Dieback or Pink disease *(Corticium Salmonicolour)* and collar rot which are not very serious on Nilgiris. Against the very serious insect pest San Jose Scale, the suggested remedies in U. S. A. are 3 percent lubricating oil emulsion or 2 percent superior-type oils or liquid lime sulphur 12 gallons to 100 gallons water. Parathion during the growing season is said to keep the pest under control. Diesel oil or fish oil and rosin, and lime sulphur have all been tried at Coonoor, with no great success. With regard to *Icercya purchasii*, it affects several other crops on the hills and for several years, quarantine restrictions have been imposed.

It may be mentioned in passing that among other fruits on the Nilgiris of a comparatively minor importance, which are not intended to be dealt with in this article, the brambles like raspberry were tried even as long ago as about 1859 by McIvor on the higher elevations. Interest in the brambles has been revived in recent years by small scale trials at Pomological Station, Coonoor.



Twigs and ripe fruits of "Kukal Orange". 2/7 natural size.

9. CITRUS IN NILGIRIS — WITH PARTICULAR REFERENCE TO "KUKAL ORANGES"

INTRODUCTION

Citrus is grown on the Nilgiri hills upto elevations reaching 5500 feet and more. The area under citrus in the Nilgiris according to Government statistics for 1949 – '50 is 796 acres. It is estimated that some years ago, the area was around 1000 acres, but the fall in the area has recently occurred due to the scrapping of quite a few orchards on account of serious decline in condition of trees and due to continued neglect. The only citrus which has a commercial status on the Nilgiris is the mandarin, *Citrus reticulata*, (Blanco). The pummelo, *Citrus grandis* (Linn.), the grape fruit *Citrus paradisi* (Macfayden), and the lemon, *Citrus Limon* (Linn.), are seen growing in a few places here and there. Some of the coffee estates have stray trees of citron, *Citrus Medica* (Linn.) and lime, *C. aurantifolia*, (Swingle). According to the Nilgiri District Gazetteer, at one time, oranges were growing wild in the Orange Valley, which thus derived its name. On this, no further information is available.

MANDARINS

The mandarins or the "loose jacket oranges" are found to thrive on a wide range of elevations in South India from the plains to elevations such as the Kukal valley between 4500 and 5500 feet. These mandarins are spread on the Nilgiris mainly in Kulakambai, Gudalur – Wynaad region, Kukal, Kunjapanai area, Kagguchi village, Naragiri and Kappatti. All enquiries indicate that Coorg was the original source of the mandarins in the Nilgiris.

The mandarins in South India derive their names from the places where they are grown, thus the *Kallar* orange, the *Kulakambai* orange, the *Kukal* orange, the *Coorg* orange etc., and they are treated as different varieties. No proper taxonomic studies have been undertaken to clear up the

varietal situation with regard to the mandarins in South India. From this point of view, it is a welcome measure that the Kallar Fruit Station has in recent years embarked on a collection of mandarins from different sources in South India such as the Kukal valley, Kulakambai, Wynaad, Lower Palnis and Kallar and in addition from the North Indian mandarin zones of Nagpur and Poona.

In varietal studies on any *Citrus* species, it is well to remember the interfering factor of climate. It has been well established that citrus is one of the fruits whose tree and fruit characters of individual varieties are affected to a surprisingly large measure by environmental factors, particularly climate. This has been brought out forcibly by a detailed study of the influences in this respect of the differing climates of Florida and California, the former characterised by a humid semi-tropical climate with about 50 inches of rainfall per year and not wide differences in temperature between day and night, as against California, with a drier sub-tropical climate with less than 30 inches of rainfall and rather wide differences between day and night temperatures. In California, the citrus fruits develop a deeper attractive colour, a thicker peelable skin enhancing the storage quality, greater acidity, and in the case of oranges, higher concentration of sugar in the juice with better flavour. Florida climate is unable to induce proper colour and the artificial colouration of oranges became the vogue in Florida to compete with the natural colour of California fruits; moreover the skin is thinner and the juice is greater in quantity but with less flavour and more insipidity in taste. This situation seems analogous to the mandarins developing a good attractive colour and flavour at the sub-tropical, comparatively drier climate of Kukal valley with 4500 to 5500 feet elevation and about 30 to 35 inches of annual rainfall while failing to develop proper colour at the humid tropical climate of Kallar with 1400 feet elevation and 60 inches of annual rainfall. It may be noted also that even the tree characters are modified by such differences in climate as observed in California and Florida.

The mandarins on the Nilgiris are propagated commercially by seed. There are certain nursery men such as

Thumbur Sevana of Jakkanare village and Daygiri Kullan who specialise in raising seedlings of mandarins and supplying them to growers. In recent years their business has not been very flourishing, due to lack of further expansion of area under mandarins. Kallar Fruit Station has also been for a long time supplying seedlings of mandarin. Lately, they have undertaken series of trials of inarching Kallar mandarin on rootstocks of other *Citrus* such as *gajanimma*, *jamberi*, *pummelo*, and *sweet lime*. The Kallar Fruit Station has found inarching successful as a method of vegetative propagation of mandarins, but budding in that station has not proved as promising.

KUKAL ORANGE

Of all the mandarins of the Nilgiris, about the most noted regarding quality and appeal to consumers is the *Kukal orange* of which a brief history, cultivation and other relevant features are given below. The writer personally visited the Kukal valley and the information given is a result of his investigation. In this connection, the assistance of Mr. N. B. Athrey, and Mr. Srikantiah well known coffee planters and orange growers is acknowledged with thanks.

This mandarin is a high quality fruit with beautiful golden orange colour of skin with a fine flavour and aroma, sweet, juicy and moderately seeded. Some of the growers claim that in the best of seasons, they have obtained good sized fruits having an average diameter of 5 inches. However the writer has noticed the present size of the bulk mandarins being about 3 inches in diameter on the average.

ORIGIN

All enquiries seem to point to the fact that P. Rangaswami Pillai of Water Fall Estate played a prominent part in the introduction of this particular strain of mandarin into the Kukal valley. It is said that he got the original plants from Kavalkombai about 8 miles from Mettupalayam and about 6 miles as the crow flies from Kallar, and the story goes that he transported the trees as such on horse back to Kukal area during the rainy season, planted them and

successfully established them. His interest in fruits seems to have been inherited from his father, Palakkara Perumal Pillai a wholesale fruit dealer.

AREA AND ENVIRONMENT

The area under Kukal orange is at present said to be about 300 acres, and is restricted to the Kukal valley, ranging in elevation from 4500 to 5500 feet. Growers have observed that the seedlings taken of the Kukal mandarin and planted elsewhere, though with almost the same elevation for example in parts of Coonoor and Kotagiri do not thrive there as well nor produce fruits of quality as excellent. It is explained that the Kukal valley is surrounded by hills and conserves more heat and has a drier climate, with 30 to 35 inches of rainfall per annum which is much less than other regions on the Nilgiris of comparable elevations, and has a larger number of sunny days in the year. It has been the observation of growers that within this zone of Kukal orange, higher the elevation smaller is the size of fruits which accords with the fundamental knowledge about *Citrus* that more sub-tropical the climate, less is the size of fruit, of which the small-fruit-size problem in Southern California is an example.

PROPAGATION AND CULTURE

As already stated, the propagation is only by seed. Growers use seedlings varying in age from 2 to 5 years. They have however noticed that the older seedlings take longer to establish. The pits dug before planting are usually of the size of 1½ feet cube. In the past, spacing given between trees has often been only 12 feet, but later plantations seem to have adopted a spacing of 18 feet. Seedlings are planted between August and October.

Regarding manurial and other cultural operations, there are many orchards which have not given much attention and consideration to the needs of the trees in this respect with the result that in several cases the decline of trees may be safely absorbed to general neglect. It is seen that where growers have given some care to culture, the orchards have been in a healthier condition.

More progressive growers apply two bushels of cattle manure per pit to start with, sometime prior to planting of trees in the new orchard. Subsequently, application of two bushels of cattle manure per tree in March – April once in two years is considered adequate by them. Lack of supply of enough manure seems to be the basis of this practice. Some of them who have tried the use of pig manure and sheep manure consider these manures harmful to the trees. Some growers have experimented with green manuring, with harmful results, due to the facilities for irrigation not having been provided and rainfall not having been sufficient to furnish adequate moisture for the growth of both the green manure crop and the trees. Adequate irrigation for the mandarin orchards is hardly given by most growers. The writer noticed some growers cultivating intercrops such as vegetables in well-grown mandarin orchards which incidentally received the water meant for the intercrops, and seemed in a healthier condition than the neighbouring orchards. Those who give attention to weeding are known to weed about three times in the year, through digging by mammoty. Pruning consists of removing only deadwood.

FRUITING

There are two seasons when fruits are obtained, once in July to September and again in December to February. The latter season may be considered the main season, yielding often five times the other. Some growers assert that this difference in yield between the two seasons was not there about ten years ago, and that they were obtaining equal yields in both the seasons, and attribute the change to alterations in seasonal rainfall noted during the last several years. Annual yields of 1000 to 1500 fruits per tree have been known; many orchards today produce only 200 to 250 fruits of medium marketable size.

MARKETING

The fruits are marketed in two ways. The fruits on the trees are sold to wholesale fruit contractors, who harvest the fruits and sell them to their dealers. The other method

adopted by some growers who are also coffee planters, is to send the fruits by their own transport all the way down to Mettupalayam or to Coimbatore, but mostly to Mettupalayam, and to sell them, through wholesale dealers who charge them normally a commission of $1\frac{1}{2}$ rupees per basket, a *mahimai* of 6 pies per basket, and an agreed wage of one anna per basket for unloading. There seems also to be a broker between the grower and the wholesale dealer who demands a commission of one anna per rupee of sale earnings of the grower. Often middlemen pay advances to growers and the latter are obliged to sell to them. The marketing system is primitive enough to warrant steps for introducing co-operative marketing, provided the growers in the solid Kukal valley unite and also organise their orange industry better.

INSECT PESTS AND DISEASES

Among the insect pests of Kukal orange are the fruit fly and the aphids about which relatively more complaints have been received from the growers. The maggots of the fruit fly *(Dacus incisus)* spoil the fruits by getting into the fruits and feeding inside. In this case the growers are advised not to retain the fruits longer than necessary on the tree, and to spray as a remedial measure crude oil emulsion at one pound in 10 gallons of water, to prevent the flies from laying eggs. The soil also must be raked to destroy the pupae. Aphids can be controlled by a 10 percent nicotine sulphate dust or a spray of nicotine sulphate with a pint in 100 gallons of water.

Among the diseases worthy of note are the mildew, the root-rots, and deficiency diseases, which last in the author's opinion are responsible for the so-called decline in Kukal orange. In the case of mildew (*Oidium* spp.) there is powdery growth of ashy white colour on the leaves and twigs. When this disease is severe, many flowers fail to open properly and fruiting is very poor. Application of fine sulphur dust or a spray of one per cent Bordeaux mixture is considered beneficial.

The remedy for root-rots depends on the kind of root-rot. Removing the soil around the base of the trunk, scraping off the dead bark and applying a lime sulphur solution, or smearing Bordeaux paste over the treated parts is among the remedies suggested. Exposing of the crown roots for a foot length from the trunk is also advocated.

Many orchards show in their trees symptoms of all sorts of deficiency diseases. The growers are advised in the first instance to make it compulsory to get into a regular manurial programme of applying organic manures in adequate quantities to the trees such as cattle manure which are natural complete fertilisers containing many of the minor elements needed for growth, but continued lack of which will result in the decline in yield and condition of trees. Growers should clearly understand in addition that nitrogen is the key-element in the nutrition of citrus and lack of application of nitrogen particularly in the organic form is known to cause deterioration of trees and such symptoms of deficiencies as the author has noted in the orchards at Kukal valley. Florida, an advanced citrus growing region, but exhibiting various deficiency diseases in citrus, follows a rational fertilisation and nutritional spray programme, including definite percentages of nitrogen, phosphorus, potassium, magnesium, zinc, manganese and copper, a standard programme of which is 4, 6, 8, 3, 1, and ½ per cent respectively in the fertiliser with pH controlled by addition of lime, plus nutritional sprays of sulphate of zinc, manganese and copper. Some such programme based on a thorough analysis of the local deficiencies may also help the Kukal orange growers to overcome the deterioration seen in many of their groves. Mixing of these chemicals requires technical assistance and should be sought, as the limitations of this paper do not permit an elaboration of these details.

THE FUTURE

The coffee planters who have been growing also the mandarins and whom I interviewed, preferred growing Kukal oranges (provided technical help was given to overcome their problems) to growing coffee, as they found

that by working out the comparative economics and by evaluating the comparative efforts, it was more profitable and easier to grow the Kukal oranges than coffee. They require guidance in better propagation, a sound manurial programme, provision of better irrigation, proper control of insect pests and diseases, and co-operative marketing as among the measures most likely to place the Kukal orange industry back on its feet and to make it expand on desirable lines. Any assistance given by the Government through particularly the Agricultural Department to this sizable industry will be worthwhile.

The area under mandarins on the Nilgiris is estimated in normal years to have been around 1,000 acres which is not a small area in a district of the size of Nilgiris and is worth greater attention altogether, in respect of horticultural research to meet the problems of the growers, and in respect of organisational efforts of the growers towards better marketing and further expansion of the area.

OTHER CITRUS

The other citrus species are of very minor importance. Pummelo is represented by stray trees here and there, and Kallar has white and pink fleshed varieties of pummelo. Triumph and Marsh Seedless varieties of grape fruit were introduced into Kallar and planted in 1935. While Triumph is a variety commercially successful in Florida's humid semi-tropical zone and is likely to be therefore more suitable in the Kallar area, Marsh Seedless has been thriving better in the sub-tropical zone of Southern California and is likely to be successful in such areas as the Kukal valley. Three varieties of sweet orange viz. Washington Navel, Blood Red, and St. Michael were also introduced into Kallar and do not seem to be thriving very well. These sweet orange varieties are likely to fare better in a drier, more sub-tropical, higher elevations. Seville lemon was also introduced into Kallar and Coonoor and it seems to be faring better at the higher elevation of Coonoor than at the lower elevation of Kallar, and this accords with the known fact that lemons require relatively cooler temperature for their proper growth.

SOME WILD FRUITS OF THE NILGIRIS.

1. Berberis tinctoria. 2. Elæocarpus oblongus. 3. Rubus lasiocarpus.
4. Pterospermum suberifolium. 5. Carissa parcinervia.
6. Zizyphus rugosa. 7. Toddalia aculeata.

10. SOME WILD FRUITS OF THE NILGIRIS

Several wild fruits of the Nilgiris appear in the local markets of the Nilgiris such as those of Coonoor, Ootacamund and Kotagiri, also on headloads during the races at Ootacamund in May, in the streets of Coonoor and Ootacamund, and at the doors of homes and confectioneries, for sale. Individual plant or tree specimens of some of these have been established at Sim's Park, Coonoor, and at Government Botanic Gardens, Ootacamund as botanic specimens. Notes on the most important of the wild fruits with identifying characters are presented here briefly with the hope that they will induce further interest in workers on fruits, to improve upon the existing wild varieties and use them in fruit-breeding work or as rootstocks for allied superior species or varieties of fruits. The fruits dealt with mostly belong to higher elevations of the Nilgiris 5500 feet and above. In obtaining the popular Tamil names and evaluating the importance of the fruits to the local people, Mr. M. K. Lingiah the Agricultural Demonstrator, Coonoor, was of considerable help. This assistance is acknowledged.

(1) *Berberis tinctoria*, Lesch. Berberidaceæ

It is popularly called the '*common Nilgiri barberry*' or '*blue bottle*' and in the local Tamil, *Oosipila*. It is a shurb, growing to a height of 6 to 8 feet, with shoots which are angular, grooved, and armed with triple spines and with green, entire, obovate leaves placed as tufts in the axils of the spines. The flowers are borne in recemes with 6 to 8 flowers having slender flower stalks. Flowers are bisexual and hexamerous and have a monocarpellary ovary. Fruits are bottleshaped and purplish red in the beginning, turning into dark blue colour when fully ripe, giving it the name "*blue bottle*". The flesh inside is dark purple in colour, very fleshy and tastes sweet.

Locally good quality jams are made out of these fruits, which are generally available in the market or from street hawkers from May to July.

The plants of this species are found in plenty in the Ketty valley.

(2) *Carissa paucinervia, A. DC.* Apocynaceæ

It is a small shrub growing to a height of two to three feet with axillary thorns and typical dichotomous branching of the shoots, characteristic of this genus. Leaves are simple, opposite, oblong and entire. Flowers are borne in axillary cymes and are white in colour, bisexual, pentamerous, with a bicarpellate ovary. Fruits are ellipsoidal in shape, red in colour, with red pulp inside, which is sweet in taste when fully ripe but slightly acidic when unripe.

The fruits are sold in the market during July to September and are also used for pickling.

This plant is found commonly everywhere in the Nilgiris inside the sholas.

(3) *Elaeocarpus oblongus*, Gaertner. Elaeocarpaceæ

It is popularly known as "*mock olive*", as the fruits have an external resemblance to olive fruits, and are called "*Bikke*" in Tamil.

It is a large sized, tall and spreading evergreen tree growing to a height of 35 to 40 feet, with an almost equal spread. Good specimens of this tree are seen in the Sim's Park, Coonoor and the species is one of the most widespread on the Nilgiris.

The twigs have prominent lenticels and the leaves are elliptic, acute, serrate, with shiny upper surface, older ones turning red in colour and falling off. Flowers are borne in racemes usually 5 to 6 inches long in the axils of older leaves which fall off. The flowers are bracteate, bisixual, pentamerous, with deep brown sepals and creamy white petals with top portion cut into lobes, and have numerous stamens and superior ovary or raised torus. The fruit is an olivelike drupe, green in colour.

The fruits taste sweet but are more powdery than fleshy. They are sold in the market mainly from April to July.

Stray fruits are available all through the year excepting December to February.

(4) *Eugenia calophyllifolia*, Wight. Myrtaceæ

It is popularly known in tamil as "*Neri palam*".

It is a large tree with widely spreading branches, growing to a height of 30 to 35 feet and an all round spread of 45 feet. The branches are dark brown in colour. The leaves are simple, opposite, lanceolate, entire, shining green in colour and very leathery in texture. Flowers are in cymose corymbs, borne terminally, bisexual, actinomorphic and tetramerous.

The fruits are dark purple, oblong in shape, juicy and fleshy and make good jams. The trees come into fruit from the end of July to September and are very common in the surrounding sholas of Coonoor.

(5) *Pterospermum suberifolium*, Lam. Sterculiaceæ

It is called "*Kulangu palam*" in Tamil.

It is a small tree growing to a height of 10 to 12 feet. The leaves are imparipinnately compound with normally 5 leaflets which are shiny white on the under surface and greenish above, and are oblong in shape. The flowers are borne in clusters of two to three in the axils of leaves, and are bisexual, pentamerous and whitish in colour. Fruits are capsules, subangular, tapering at both ends, reddish brown in colour and contains fleshy pulp. The fruits are usually found during March to May and suitable for making jam.

(6) *Rhodomyrtus tomentosa*, Wight. Myrtaceæ

It is called hill gooseberry and popularly known in Tamil as *Thavattu palam*. It is a shrub growing to a height of six to seven feet and is found very commonly in all the shola areas throughout the Nilgiris.

It is identified by its characteristic hairy branches and leaves which have dull green colour, and are three nerved. Leaves in the lower portions of the stem are always in threes

and in the upper portions opposite in nature. The flowers are borne in pink coloured cymose corymbs arising from the axils of leaves. The pink appearance of the flowers is on account of the numerous pink stamens. The sepals and petals are five and united.

The fruit is a berry, globular and cherry like and yellowish green, when fully ripe. The pulp is fleshy, sweet and aromatic. The fruits come out from October to December and are mostly sold by street vendors. The fruits are eaten out of hand or made into jam called "*Thaonty*".

(7) *Rubus ellipticus*, Smith. Rosaceæ

It is popularly called yellow bramble or yellow raspberry. It is known in the local Badaga language as *Mulli hannu*.

It is a tall-growing prickly shrub, with stems covered very densely with red hairs and armed with stout prickles. Leaves are trifoliate and leaflets are elliptic in shape, dark green above and whitish beneath, with mid-ribs having tiny prickles which are modifications of the epidermal hairs. The flowers are borne in racemose panicles at the axils of the leaves, each panicle usually 8 to 9 flowered. Sepals are acute and petals are obovate.

The fruit is an aggregation of drupelets, globular in shape, juicy and sweet and is suitable for making jams whose flavour is similar to that of raspberry jam. The fruits are obtained between January and March, and stray fruits can be seen in all parts of the year.

(8) *Rubus lasiocarpus*, Smith. Rosaceae·

It is popularly called the wild raspberry.

It is a rambling shrub, growing luxuriantly in the sholas of the Nilgiris, especially in the Ketti valley.

This plant is distinguished from *Rubus ellipticus* by its characteristic smaller leaves which are five-foliate and are obovate in shape, borne on reddish brown branches which are often cylindric and armed with small compressed prickles. The venation of the leaflets is again another characteristic

feature of this plant with five to ten pairs of veins running right up to the margin of the leaves. Flowers are in corymbs axillary as well as terminal, usually 5 to 8 flowered, borne on short pedlicels. Sepals are acute and triangular in shape and petals are deep pink and obovate.

The fruit is an aggregation of drupelets, red in colour and very fleshy, the flesh being deep purple. The fruiting season is from the middle of May to the end of July. Of the indigenous raspberries on the hills, this is the best flavoured and most plentiful.

These plants are abundant in the Ketti valley.

(9) *Toddalia aculeata*, Pers. Rutaceæ

It is known in Tamil as "*Moola carnay maram*".

It is a woody shrub growing to height of 5 to 6 feet and is characterised by twigs armed with curved prickles and by the trifoliate dark green leaves which are obtuse. Flowers are borne in cymes which are generally axillary and sometimes terminal, white in colour and pentamerous.

The fruits are subglobose having five segments, fleshy inside and slightly subacidic in taste. The plants are in fruit only during July to September on the hills.

(10) *Vaccinuem leschenaultii*, Wight. Ericaceæ

It is popularly known as *blueberry*, or "*bilberry*" and is called in Tamil as "*Kila palam*".

It is a medium tree growing to a height of 20 feet and usually has a spread of 15 feet. The tree is characterised by its rough bark, and leaves being pinkish coloured when young. Leaves are simple, alternate, and elliptic in shape. Flowers are pinkish rose in colour and are always borne in terminal racemose clusters. The sepals and petals are five in number.

Fruits are pinkish berries. The pulp is purplish red in colour and is fleshy and tastes aweet. It is often sold in the market in small baskets by street vendors during the end of

June to August. The fruits are used for making jams and are also used in making cakes.

(11) *Zizyphus rugosa*, Lam. Rhamnaceæ

It grows as a semi-woody shrub fully armed with curved prickles. The leaves are alternate, leathery and have the characteristic three main veins. Flowers are borne in long peduncled cymes on long branches which are characterised by the absence of leaves. Flowers are pentamerous, bisexual and have superior ovaries. The fruit is a drupe and is more powdery than fleshy inside. The fruits are sweet and palatable and are supposed to afford important food to the inhabitants of the Ghauts. The fruits are available from March to the end of June.

11. MEDICINAL PLANTS IN THE NILGIRIS

The Government Botanic Gardens, Ootacamund, from its very inception had interested itself in introduction and trial of medicinal and drug plants. The major event in this line was *the introduction of cinchona in the year 1860*, by the Superintendent of these Government Botanic Gardens, with such signal success that to-day cinchona alone has expanded into 2320 acres of Government plantations on the hill zones of Madras State and has a separate Government Department to organise its development and research. In 1878, an organised plot of medicinal gardens was established in the *Botanic Gardens, Ootacamund. Among other medicinal* plants, the jalap (Ipomoea Purga) was successfully grown at the Botanic Gardens, and attained on the Nilgiris an important commercial status and in fact commanded an excellent market in London, particularly around the year 1923. Blue gum, *Eucalyptus globulus*, introduced in 1843 for the first time in India, on the Nilgiris, expanded rapidly, accompanied by development of distilling units as cottage industry for manufacture of eucalyptus oil, solely for medicinal purposes, and to-day the Nilgiri district holds almost the monopoly for supply of eucalyptus oil to the country as a whole. In recent years, since 1942, the Mycology Section of the Madras Department of Agriculture has made outstanding success worthy of national attention, in producing ergot on rye on the Nilgiris, and enabled India to possess a key drug in sufficient quantities, originally held exclusively by only a few countries such as Spain, Portugal and Russia. A number of medicinal plants have been introduced for trial from time to time on also the various research stations of the Agricultural Department on the Nilgiris. The following brief notes relate to medicinal plants which either have been grown successfully on the Nilgiris on a commercial scale or have shown promise of success in small scale trials, and are worthy of further large scale trials.

1. **Acorus calamus,** Linn. Sweet Flag. (Tamil: Asambu) *Araceae*.

This is an erect plant with a more or less horizontal aromatic root-stock (rhizome), with a leaflike spathe and dense flowered sessile spadix,

with yellow green bisexual flowers producing yellowish green angular berries. On the Nilgiris it can be cultivated upto about 8,000 feet.

The aromatic nature of the plant is on account of the presence of an essential oil, containing the glucoside *acorin*. It is also said to contain phenolic ether, asarone, and terpenes and equiterpene derivatives in very small quantities.

It is an expectorant, nervine, sedative, stomachic, carminative and antiperiodic. Dried rhizomes can be used in the form of infusion to treat dyspepsia, flatulence, loss of appetite, children's diorrhoea, hysteria, neuralgia, cough, bronchitis and asthma.

Calamus root in powdered form is also used for sachet and toilet powders, while the distilled oil is used in perfumeries.

2. **Cephaelis Ipecacuanha,** Willd. (*Psychotria Ipecauanha*, Muell-Arg. *Uragoga Ipecacuanha*, Baill). Ipecacuanha. *Rubiaceae.*

This is a low, creeping, herbaceous plant with oblong, ovate, entire leaves, pubescent beneath, pendulous involuocrate flower heads, and slender, knotty roots.

The commercial *ipecac* is produced from the roots. Brazil has a large export trade in ipecac, prepared from the wild plants of ipecacuanha in its forests.

The ipecac plant contains many alhaloids, chief of which is *emetine*. Ipecac is used chiefly as an emetic and expectorant.

The plant is best propagated by divisions or stem cuttings. The plants come to harvest in about 2½ years from planting. Malaya records 50—60 pounds per acre of dried roots.

On the Nilgiris, trials with seeds of ipecacuanha were conducted in the research stations of the Madras Agricultural Department at Nanjanad, Ootacamund, Coonoor, and Kallar. While the seeds failed to germinate at all the research stations of higher elevations, they germinated at Kallar (1,200–1,400 feet elevation) and the plants subsequently grew for many years. It is reported however that the plants did not analyse satisfactorily for cephalin which was low in content. Selection of a suitable strain is needed.

3. **Cinchona spp.** Cinchona. *Rubiaceae.*

Quinine, for a long time the only antidote against malaria, is obtained from the bark of cinchona.

The chief sources of commercial bark on the Nilgiris have been *C. officinalis*, *C. Ledgeriana*, *C. calisaya*, *C. succirubra*, *C. robusta* and *C. eurutusinga*, and their natural hybrids.

Cinchona owes its origin in India to the Government Botanic Gardens, Ootacamund which introduced the plants and developed techniques of propagation and culture to suit their new environments. It has now become a major plantation industry both on the Nilgiris and other hill zones of South India. (See separate article on "Cinchona industry in the Madras State with particular reference to the Nilgiris").

4. **Cinnamonum Camphora,** Nees and Eberm. Camphor. *Lauraceae.*

This tree is a native of China, Japan and Formosa but has been widely introduced into various tropical and sub-tropical regions but mainly as an ornamental plant.

Fine specimens of these are seen in Sim's Park, Coonoor (5,900 feet elevation) growing into fairly large trees 70 feet high, with an equal spread and trunk diameter of about 10 feet. Trees are seen also here and there in estates. The tree has a dense top, with aromatic leaves and inconspicuous yellow flowers. The encouraging growth of these trees deserves attention and further work towards industrial exploitation.

The proper method of growing camphor commercially is to sow the seed in nursery and plant out the seedlings at a spacing of 8 by 8 feet. After 3 or 4 years, the annual growths are clipped from the trees and the clippings are chipped and distilled. Two products are obtained, viz. the solid crystalline camphor deposited on the sides of condensing boxes, and camphor oil as a liquid.

The synthetic camphor prepared from terpentine is a competitor to the natural camphor which however is still an industry in Formosa and Japan. Besides having a range of medicinal uses and being useful as disinfectant, it is used in the manufacture of celluloid, xylonite, smokeless gun powder, and incense.

5. **Claviceps purpurea**, Tul. Ergot.

Ergot can be explained in a simple language as the fruiting body of a fungus, *Claviceps purpurea*, which is a parasite on rye and other grasses. Starting with cultures of fungus from Australia for the first time in 1942, at the Agricultural Research Station, Nanjanad, the Mycology Section of the Madras Agricultural Department successfully pursued its artificial parasitisation on rye and to-day, the commercial production of ergot organised by this section of the Agricultural Department can be said to be a major contribution to India's drug industry. For producing commercial ergot, rye is grown on field scale and when it comes to flower, the open flowers are sprayed with spore suspensions of the fungus inducing the fungus growth in the rye earheads. The treated earheads produce ergot instead of grains. For processing of ergot, the crude ergot is defatted and the powdered ergot is standardised into (1) Ergota preparata (powder) containing 0·20% ergetoxine and (ii) Extractum ergotae (liquid) containing 0·05% of the alkaloid. The Alkaloids contained in ergot include ergetoxine, ergotamine, ergometrine and ergotimine, of which orgetoxine and ergometrine are most important.

Ergot is most useful medicinally in cases of hemorrhages and uterine disturbances.

6. **Erythroxylon Coca**, Lam. Coca. *Erythroxylaceae.*

This plant is a native of Peru and Bolivia, and is extensively cultivated in South America, Java and Formosa. The drug, Cocaine is obtained by distillation from leaves of this plant.

On the Nilgiris, it can thrive in elevations ranging between 2,000 and 5,000 feet. This plant requires for its best development a very humid atmosphere and a comparatively higher elevation.

It is propagated usually by seed, though cuttings can also be used. The seedlings are transplanted. The first plucking of leaves can be made when the seedlings are about two years old. Fully mature leaves are picked and dried quickly and they are packed well pressed in airtight bales or containers for shipment.

Several alkaloids are contained in the leaves, which are derived from ecgonine, the most important of which is cocaine. Crude cocaine can be obtained by powdering the dry leaves and mixing them with slaked lime and extracting with ether. This can be further purified by acid treatment and other suitable chemical methods.

Cocaine is a well known local anaesthetic. It is also used as a tonic for digestive and nervous systems but is habit forming. In South America, the leaves are used as a masticatory.

7. **Digitalis purpurea,** Linn. Foxglove. *Scrophulariaceae*

It is a herbaceous plant mostly biennial and some times perennial producing long racemes of 'inflated flowers', suggesting spires or towers of bells. While it is an important medicinal plant, it is equally important as an ornamental plant.

Several preparations of *D. purpurea* are made for medicinal purposes as diuretic, sedative and narcotic. For these purposes, fresh full grown leaves of the second year's growth are picked and quickly dried for use as source of the drug, *digitalis.*

These plants are seen to grow very luxuriantly in the Coonoor and Ootacamund areas (5,500 to 7,700 feet) and it is desirable that attention is directed towards exploiting the industrial potentiality of this plant on the Nilgiris.

The most active principle in the drug, *digitalis* is a glucoside, *digitoxin.* This drug is most essential in treatment of heart disorders.

There is a good deal of interest shown by certain pharmaceutical companies in the possibilities of introduction and trial of *Digitalis lanata*, an allied species to foxglove, on the Nilgiris.

8. **Eucalyptus globulus,** Labill. Blue Gum. *Myrtaceae*

The Nilgiri District holds almost the monopoly in India for production of essential oil from the blue gum. The Eucalyptus oil industry on the Nilgiris is more than a hundred years old. The eucalyptus oil obtained from the leaves is used chiefly in the disorders of the nose and throat, and in malaria. It is also an antiseptic and febrifuge. (See also articles on "Eucalyptus on the Nilgiris" and "Essential Oil Plants on the Nilgiris").

9. **Eugenia caryophyllata,** Thumb. (*Engenia aromatica*, Baill; *Caryophyllus armoticus*, Linn., *Jambosa Caryophyllus*, Ndz.) Clove tree. *Myrtaceae*

While clove is one of the most important spices, the essential oil obtained by distilling cloves with water or steam, has various uses in medicine. It aids digestion, and is antiseptic, antispasmodic, and counter-irritant. It is particularly a local antiseptic in toothache. Many tooth pastes and mouth washes have this clove oil as an ingredient.

The clove tree is well established on the lower slopes of the Nilgiris upto about 3,000 feet above mean sea level with its humid tropical climate and an annual rainfall around 60 inches. Further expansion of cloves and industrial exploitation is worthwhile. (See also article on "Spices in the Nilgiris".)

10. **Gaultheria fragrantissima,** Wall. *Ericaceae.*

This plant is commonly found on the hill zones of not only Nilgiris in South India, but also in Nepal, Bhutan, Khasi Hills, the Western Ghats, Palni hills and hills of Travancore.

It yields an essential oil, wintergreen oil, from which salicylic acid used in the preparation of aspirin can be obtained. The oil is a good antiseptic. It is said to be used also in the manufacture of insecticides and insect repellents.

It is a stout shrub with triangular branches and leathery lanceolate to ovate, dentate leaves, and pubescent racemes.

11. **Ipomoea Purga,** Hayne. Jalap. *Convulaceae.*

This plant is the source of the "Jalap" of commerce which is a very active purgative. Jalap is prepared by grinding into powder dried slices of the tuberous roots of this species. The word "Jalap" is a corruption of the name of a place in Mexico called Xalapa round about which the roots of this species used to be originally collected.

It is a climber, propagated from cuttings or from the tubercles on the roots. It was intensively cultivated in Nilgiris, particularly in the Government Botanic Gardens, Ootacamund from 1922 to 1926. As already stated, jalap from Nilgiris had good market in England during these years. However, there was decline in demand subsequently and there has not been much interest in it in recent years. A crop of about 1,000 lb. of root *tubercles can be obtained every third year from the plants, when* properly grown.

12. **Mentha piperita,** Linn. Peppermint. *Labiatae.*

It is a perennial, highly aromatic herb. Peppermint oil is distilled from the shoots and the leaves; and in medicine, it is an antiseptic, stimulant and carminative. *Menthol*, a white crystalline substance is also obtained from the peppermint oil and is known to be a valuable antiseptic highly useful in the treatment of colds.

This is suitable only for higher elevations of Nilgiris and is propagated by cuttings or slips. Within about three months after planting, the plants are ready for cuttings which can be subsequently taken at intervals of three months.

13. **Mentha viridis,** Linn. Spearmint. *Labiatae.*

This can be grown both in the plains and higher elevations. It is also a good medicinal plant. The sweetened infusion is said to be an excellent remedy for infantile troubles, against vomiting in pregnancy and against hysteria.

14. **Myristica fragrans,** Houtt. Nutmeg and Mace. *Myristicaceae.*

This tree is more noted for the spices, nutmeg and mace. (Please vide article on "Spices in the Nilgiris" for greater details on this tree). An essential oil is extracted from the nutmeg, which contains a highly toxic substance, *myristicin* and is used medicinally, in small amounts. The nutmeg as such is known to have medicinal values. Even carrying a nut

on one's person is said to cure him of lumbago and rhemuatism. An ointment made of nutmeg powder is said to be an excellent application against rheumatic pains, sprains and piles.

15. **Myroxylon toluiferum,** HBK. Tolu Balsam Treo *Leguminosae.*

This tree belongs to tropical America, (Venezuela, Colombia and Peru), and is a source of the Balsam of Tolu, a pathological product of the tree. Balsam of Tolu, is a brown or yellowish brown plastic gum-resin with a pleasant aromatic taste and odour. It is used for salves and ointments and as an expectorant and antiseptic in the treatment of coughs, colds and bronchitis. Cough syrups are also flavoured with this. Large quantities are also used as fixatives in the perfume industry.

Under good conditions, the tree grows up to 75 feet or more. Introduced at Kallar (1,400 feet elevation), it was at first showing slow growth, followed by fairly satisfactory growth. A well grown tree has rough bark and straight stem.

In the countries where Balsam of Tolu is prepared commercially, V-shaped incisions are made in the trunk and the balsam which slowly exudes is collected in gourds. The gum is filtered through cloth and boiled.

16. **Rosmarinus officinalis,** Linn. Rosemary. *Labiatae.*

It is a native of the Mediterranean region and a well known garden plant, with aromatic leaves, suitable for higher elevations of the Nilgiris.

A volatile oil, rosemary, is distilled from the leaves and is useful in medicinal preparations. It is also used in Eau de cologne, and toilet soap. An infusion from the leaves of rosemary combined with borax and other herbs is said to make a good hair-wash preventing mature baldness.

17. **Ruta graveolens,** Linn. Rue. Herb of graco. *Rutaceae.*

This is a small perennial under-shrub, woody at the base with leaves which have strong aromatic odour and bitter taste. While this can be grown at lower and medium elevations, it does best at the higher elevations of Nilgiris. It can be propagated either from seeds or cuttings.

The leaves are used in medicine as a stimulant and carminative, expectorant, anthelmintic, antispasmodic, and found useful against amenorrhoea and hysteria.

Known in Tamil as *Arvada Thalai* or *Nagathali*, it is used by the indigenous population of Nilgiris against children's fever. Even the aroma from the leaves tied in bundles and hung inside the house is said to be effective in allaying the fever.

18. **Thymus vulgaris,** Linn. Common Thyme. *Labiatae.*

This is a native of the Mediterranean region and is a sub-shrub well-branched but with a prostrate habit. It grows well on the higher elevations of Nilgiris and can be propagated by seed or by division.

While the essential oil is used in perfumery, *thymol* derived from the oil is used in mouthwashes, toothpastes; and as an internal medicine, it aids in roleiving colds, colic, and pulmonary troubles.

It is also popular as a seasoning herb in soups, sauces, dressings and gravies.

While most of the plants listed above either have already shown *commercial and industrial possibilities* or have a *great scope for further* work and expansion, there are other plants on the Nilgiris growing wild as weeds or are easily accessible as garden plants, which the indigenous *population have come to use in their home medicinal preparations*. For instance, *Leucas aspera* (Tamil: Thumbai) growing wild on the hills is very much used against eczemas and ulcers. The leaves are well ground, mixed with lime juice and aplied. *Oxalis acetosella:* (Tamil: Puliyarai, Pulia kire; Canarese: Hulla Majjigai) is a common weed on the Nilgiris and very much used against biliousness, a common ailment on the hills. Even chewing a few leaves is said to be efficiacious in this respect. *Aloe saponaria*, (Tamil: Sothukathalai) is very much found in the villages in the hills and the juice of this aloe is used against rheumatic pains. *Dodonaea viscosa*, (Tamil: Verali) is also being used medicinally in baths and fomentations against sprains, and rheumatic pains. Its leaves are ground and used as poultice in wounds and sores. The leathery skin of fruits of mangosteen (*Garcinia mangostana*), growing in the lower elevations of Nilgiris has become well known for its efficacy against dysentry, through its unfusion.

There are many other common or garden plants grown on the Nilgiris which have medicinal value, including *Buxus sempervirens* (Box), calendula, *canna*, cypropedium, *Hedera helix* (ivy), lavendula, *Osmunda reglalis*, *Rubus idaeus*, *Salvia*, *Sempervivum tectorum*. *Vinca major*. but the scope and limitations of this paper do not permit any elaborate details of the medicinal qualities of these plants.

THE FUTURE

While the Government of India for many years has been showing interest in utilizing the natural resources of the country for encouraging cultivation of medicinal plants and herbs, and at intervals appointed committees to investigate into this aspect, little has been concretely done on all India scale and almost nothing in the Madras State. Recently, the Medicinal Plants Committee of the Indian Council of Agricultural Research, after consultation with the Indian Chemical Manufacturers' Association, drew up a scheme for research on medicinal plants and it was encouraging to find that a scheme for the Nilgiris was also drawn up. The list of plants recommended for trial in the Nilgiris included:

(1) **Anthemis nobilis,** Linn. Chamomile, (compositae), infusions from the flower heads of which are used as tonics and gastric stimulants,

(2) **Chenopodium ambrisioides**, Linn. Var. *anthelimintieum*, Gray. the worm seed, (Chenopodieae), oil from the fruit heads of which is used in hookworm and other worm treatments,

(3) **Evonymus atropurpurea,** Jacq. (Celastraceae) whose bark has well known medical properties,

(4) **Hydrastis 'canadensis,** Linn. Goldenseal, (Ranunculaceae), whoose roots and rhizomes contain several alkaloids,

(5) **Lobelia inflata,** Lobelia, Indian tobacco, (Campanulaceae) from whose dried leaves and tops, the drug *lobelia* is obtained, whose active principle is an alkaloid and which is used as an expectorant, antispasmodic, and emetic,

(6) **Mentha piperita,** Peppermint which has already been dealt with above.

(7) **Physostigma venenosum,** Calabar bean (Leguminosae), whose dark brown seeds are the source of well known poison with medicinal uses,

(8) **Polygala chinensis,** (Polygalaceae), whose roots are poisonous and are of medicinal value,

(9) **Polygala senega,** Seneka Snakeroot, Mountain Flax, (Polygalaceae) from whose dried roots are obtained the drug *senega*, used as an expectorant, emetic and stimulatant,

(10) **Prunus virginiana,** Mill. (Rosaceae) whose bark is of medicinal value,

(11) **Rhamnus Purshiana,** DC., Cascara Sagrada, (Rhamnaceae) from the bark of which is obtained the familiar drug, *cascara*, a tonic and a laxative,

(12) **Rheum palmatum,** Linn., (Polyganaceae) dried rhizomes of which are used medicinally, as a tonic, laxative and for indigestion,

(13) **Rosmarinus officianalis,** rosemary which has been dealt with above,

(14) **Smilax ornata,** (Liliaceae), whose short thick rhizomes are the source of the well known *sarsaparilla*,

(15) **Swertia chirata** (Gentianaceae) which is used medicinally, as a *bitter tonic, stomachic, febrifuge, and anthelmentic,*

(16) **Viburnum prunifolium,** Black Haw, Stag Bush whose bark is of medicinal value.

It is suggested that in any future investigations on the Nilgiri hills, the following are also included. Most of them are meant for higher elevations.

(1) **Abies Webbiana,** Lindl. (Coniferae), leaves of which are used as tonic and astingent in diseases like asthma and bronchitis.

(2) **Aconitum heterophyllum** (Ranunculaceae), tuberous roots of which are used in fevers, diarrhoea, dyspepsia and cough, and also as aphrodisiac.

(3) **Aconitnm Napellus,** Linn. (Ranunculaceae) from whose roots are obtained the drug *aconite* which contains the alkaloid *aconitine* and is used externally for neuraligia and rheumatism and internally to relieve fever and pain.

(4) **Amomum subulatum,** (Zingiberaceae), used in neuralgia and snake bites, and scorpion bites. Suitable for all elevations.

(5) **Artemisia maritima,** wormwood (Compositae) the chief source of the drug *santonine*, anthelmintic, cardiac, and respiratory stimulant.

(6) **Atropa Belladonna,** Linn., Belladonna, (Solanaceae), whose dried leaves and tops are the source of the important drug *belladonna*, used externally to relieve pain and internally to check perspiration, coughs etc. *Atropine* derived from the leaves is applied for dilating the eye.

(7) **Berberis aristata** (Berberidaceae) which yields an alkaloid used as antipyretic, antiperiodic, diaphoretic and tonic.

(8) **Boswellia thurifera,** (Burseraceae), yielding a gum useful as demulcent, aperient, alterative, purifier of blood, refrigerant, dieueretic and astringent.

(9) **Colchicum antumnale,** Linn. (Liliaceae) from whose dried corms are extracted an alkaloid used in treatment of rheumatism and gout.

(10) **Colchicum Luteum,**. Baker., (Liliaceae) whose importance is *similar to C. autumnale.*

(11) **Ephedra geraridina,** (Gnetaceae), from which is obtained the alkaloid *ephedrine*, used in the treatment of colds and for other medicinal purposes.

(12) **Ferula rubricaulis,** (umibelliferae), oil resin from which is of high medicinal value.

(13) **Gentiana lutea,** Linn., (Gentianaceae), whose roots contain several glucosides valuable as tonic.

(14) **Grindelia cuneifolia,** (Compositae), which as a medicinal herb is very valuable.

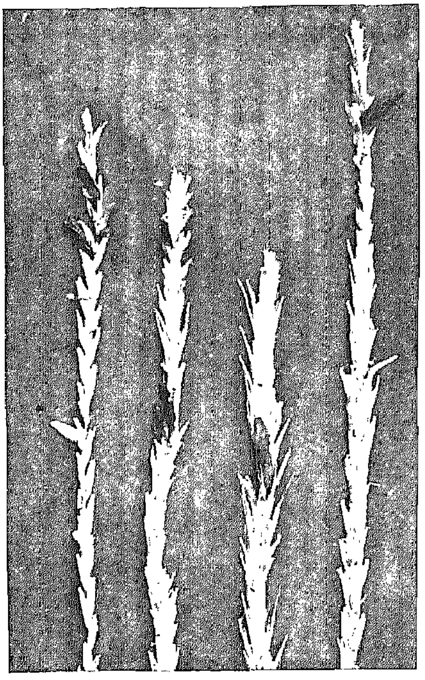
(15) **Hyoscyamus muticus,** (Solanceae), whose importance is similar to *H. niger* mentioned below.

(16) **Hyoscyamus niger,** Linn., (Solanaceae) whose seeds, leaves and green tops yield the alkaloid **hyoscyamine,** used as a sedative.

(17) **Lobelia nicoteanifolia** (Campanulaceae), whose importance is similar to *L. inflata* which has been mentioned already.

(18) **Podophyllum emodi** (Berberidaceae), whose rhizomes are of cathartic value.

Every sincere effort to establish valuable medicinal plants, providing also raw material for the Indian drug industry, will increase the national wealth of the country. Often the finance spent by the Government in such investigations will be repaid hundred-fold by achievements in increase of national resources and in introduction of new industries.



Earheads of rye with ergot formation

12. ERGOT FROM RYE ON THE NILGIRIS

by D. MARUDARAJAN, B. A.
Government Mycologist, Agricultural College and Research Institute, Coimbatore

Recently during the World War II, the Agricultural Department started a new venture on the Nilgiri Hills, for the production of ergot by cultivating rye and artificially inoculating the flowers with the culture of the ergot fungus.

Ergot is a drug consisting of the dried sclerotium of a fungus called *Claviceps purpurea*, developed on the flowers of the rye plant. Before the discovery of its use as a drug, it was known as a serious disease of the rye plant. In addition to its being a disease of the rye, consumption of rye grains with these sclerotia caused serious diseases in men and animals, resulting in excruciating pain and often death; and the disease has been long known as *ergotism*. Investigations showed that the fatal maladies were due to the poisonous nature of the ergot sclerotia developing on the rye grains. Further investigations brought out more knowledge concerning ergot and its medicinal virtues and proved to be an important drug particularly useful in the treatment of *post partum* hæmorrhage. Although the medicinal properties of ergot were known by modern Europe only from the early nineteenth century, there are evidences to show its use in midwifery from ancient times in the Middle and Far East. Some authorities report that the ergotized grains were used in Chinese midwifery from a very early period. Arabians also seem to have put it to similar uses. A Moorish physician indicates that the fungus was used medicinally during the 10th century in his country.

The importance of ergot as a medicine is due to its several important alkaloidal constituents such as ergotoxine, ergometrine, ergotamine and ergotinine of which ergotoxine and ergometrine are more important. Since the acceptance of ergot into official medicine, the source of supplies of the drug was mainly from Baltic States, Spain,

Portugal, Poland and Russia from collections from the naturally infected rye crop. Since rye was not being cultivated to any extent in India, the requirements of this drug in India were being entirely met by imports from foreign sources. During World War II, the supplies of this drug to Indian hospitals could not be met by imports. Further, the drug assumed a greater importance on account of its use by the army for arresting hæmorrhage and relieving bomb shock. There was thus a great and insistent demand from the army personnel for their use of the drug among the war casualties. At this juncture, to meet the emergency, the Madras Department of Agriculture initiated the artificial production of ergot from rye on the Nilgiris in the year 1942 and made it available to pharmaceutical firms who process the ergot into *Ergota preparata* and *Extractum ergotae liquidum* for oral administration and further purify it for injections. When the work was first taken up, a limited area at the Agricultural Research Station, Nanjanad, was being cultivated with a variety of rye said to be of Italian origin. A few other varieties were also obtained from Kashmir and other places in India and also from Australia where ergot production by artificial inoculation had already been proved as a practical possibility. Fresh cultures of the fungus *Claviceps purpurea* were obtained through the courtesy of Dr. Magee and Mr. I. A. Watson of Australia. Though the stock cultures were maintained on special agar media, for purposes of spray inoculation, the cultures were grown on rye grains sterilized in ordinary pint bottles, by filling bottles to one-third of the capacity with clean rye grains and an equal quantity of water and then plugging and autoclaving them for about three-quarters of an hour to ensure thorough sterilisation.

Rye is a crop of the temperate zone, and the trials made on the Nilgiris showed that it could be grown successfully only on higher elevations of 5,600 feet and more. Of the various varieties of rye tried, the variety being grown at Nanjanad and the Australian were found to be suitable for large scale ergot production. Regarding the time of sowing to obtain maximum infection, it was found that on the Nilgiris, good yields were obtained in sowings done between April and July. Sowings after August were found

inadvisable. There was found to be distinct correlation between the number of rainy days during the flowering period and the yield of ergot—the more the rainy days, the greater the yield. But heavy rain during the maturing stages of ergot caused lodging of rye and shedding of ergot.

As already stated, cultures of the fungus are multiplied on sterilized rye grains, and in a month after inoculation, good sporulation is obtained. Spore suspensions are prepared with such cultures for spray inoculations. The spray inoculations are found to be effective in producing optimum infection only when the spray is able to get at the open flowers after anthesis. As all of them do not open at the same time, six to eight sprays at the rate of two sprays a week are necessary to cover the period of anthesis. About 40 to 50 bottles of culture are required to spray an acre eight times.

The usefulness of ergot depends on its alkaloid content. The sclerotia produced during the first year of trial were analysed and found to be quite as good as the imported product. But the average alkaloid content of the best imported Spanish ergot is only 0·19 per cent just about equal to the B. P. standard. Russian ergot contains only 0·06 to 0·1 per cent. With the idea of improving the alkaloidal content of the Nilgiri ergot, sclerotia having high alkaloid content were selected and cultured. By such repeated selections and culture, the Madras Department of Agriculture has been able to get cultures from individual sclerotia giving an alkaloidal content of 1·19 per cent analysed for ergotoxine. This is about six times the alkaloidal content of the imported spanish product. By such methods, the average has so far been maintained at more than twice the alkaloidal content of the imported product.

The scheme financed by the Madras Government for the large scale production of ergot has been in operation on the Nilgiris from 1944. During the few years that the scheme has been in operation, it has been realised that the most important factor for getting high yields is the synchronization of the time of flowering with the prevalence of misty weather or light rains. Besides this, the fields should not be situated on tops of hills or exposed to strong winds, and

water facilities should exist for spraying. The yield of ergot depends also on the fertility of the land and the attention bestowed on the various operations by the growers. In Sholada (Nilgiris) one farmer was able to harvest 328 pounds of dried ergot from an area of three acres. The yield in this case works out to 109 lb. per acre and at the price of Rupees sixtyfive per pound existing at the time of writing, the returns amount to Rs. 7,085/- per acre. It has been found that in storage, ergot is attacked by insects or spoiled by moist conditions. Drying thoroughly in the sun and storing in moisture proof containers can maintain the ergot in storage for one or two years. Ergot has 25 per cent fat, and defatting improves quality. Considering the necessity for expansion of production of ergot, and for its production and research under properly controlled conditions, the Government have sanctioned a farm of about 40 acres, about five miles from Ootacamund in a place called Rees' corner (part of forest land), in Muthorai village, protected from winds and enjoying both the North East and South West monsoons. For the last few years, a target of 100 acres under rye for ergot has been maintained every year, mostly on private lands.

Thus, through the efforts of the Madras Agricultural Department on the Nilgiris, production of a key drug for the nation in sufficient quantities has been achieved.

13. CULTIVATION OF PYRETHRUM ON THE NILGIRIS

by K. N. RAGHAVAN NAIR
Provincial Silviculturist,
Ootacamund

Among the numerous vegetable and chemical insecticides of the world, pyrethrum, *Chrysanthemum cinerariæfolium* (compositae), occupies a unique place on account of both its cheapness and its wide applicability in its pure form and in mixture with other insecticides. One of the most remarkable features of pyrethrum is its lightning action on the insects and it is therefore invaluable in any campaign where a quick "knock down" is essential.

Chrysanthemum cinnerariæfolium is a glaucous perennial 18 to 24 inches high. To the casual observer, pyrethrum resembles the ordinary field daisy but the two are readily distinguishable. The stems are unbranched and slightly hairy. The leaves are petioled and finely cut. "The dried flower heads are hemispherical and consist of a short rounded receptacle; a straw coloured involucre composed of three rows of scales; a disc composed of numerous yellow flowers; a circle of white or cream coloured ray florets."

INTRODUCTION OF PYRETHRUM INTO INDIA

The importance of pyrethrum, not only as a valuable anti-malarial insecticide but also as an easy means of keeping the soldiers free from ticks and body lice, was first realised during the Burma and Malayan campaigns of the last war. The loss of the Japanese source of supply and the ever increasing demand resulted in an all-out effort to find out suitable places to grow pyrethrum for the Allies. Accordingly, experiments were started in several parts of India in 1942 with the seeds obtained from Kenya, and after a number of small scale trials, it was found that the Nilgiris, having almost the same climatic conditions as the Kenya

highlands, offered an ideal place for the large scale cultivation of pyrethrum. Large scale plantations were begun in 1943, with an area of 1400·88 acres. In the following year, an additional 466·64 acres were brought under pyrethrum making a total of 1867·52 acres for the Nilgiris and a separate pyrethrum division was formed in charge of a District Forest Officer.

SILVICULTURAL REQUIREMENTS

Soil: Pyrethrum is comparatively indifferent to the type of soil in which it grows. But it however requires good drainage, and soils with a clay pan or murram close to the surface would therefore be unsuitable. Very rich forest soils should also be excluded, so as to avoid excessive vegetative growth (leaf) to the detriment of flower production. Diseases such as root-rot also seem to be more prevalent on such soils. Generally speaking, loams derived from volcanic rocks, capable of retaining the moisture content during the dry weather are the most suitable.

In the Nilgiris, pyrethrum has been raised in two types of soils, black loam in which the proportion of clay is slightly higher and a red loam which is lateritic in origin, with a pH value varying from 3 to 5·1. The parent rock in both cases is a fine grained gneiss. There has been no significant difference in the growth and production of flowers in the two types of soils. In South India, pyrethrum has been grown in virgin soils, although in Kenya, Dalmatia and Japan, virgin soils are strictly avoided on account of the very poor yield during the first year. Some cereal crop such as wheat, rye, barley, or oats is grown during the first year and this is followed by pyrethrum. This practice has given a significantly higher yield, particularly in Kenya.

Altitude: In Nilgiris (latitude 8 to 11 degrees North), pyrethrum grows well at elevations varying from 6000 to 8000 feet, the best growth being found above 7000 feet. At lower elevations, although the plant grows, the production of flowers is comparatively very low and it is not therefore economical to raise it on a large scale. Pyrethrum is highly sensitive to frost in its early stages and care should be taken

to avoid frosty localities especially at elevations above 7500 feet. Similarly, highly exposed areas are unsuitable as the cold winds in winter inhibit the growth of the bushes. However, if suitable wind belts are provided, the plants grow very well in such localities.

Rainfall : Pyrethrum can thrive even with a scanty rainfall but its monthly distribution is most important, because pyrethrum suffers very badly under prolonged drought. Generally speaking, a rainfall of 40 to 45 inches distributed over a period of 10 to 11 months in the year is most desirable. In regions of heavy rainfall, the plants suffer very badly from "damping-off" and what is more, the soil-wash will also be excessive, resulting in an appreciable fall in the yield.

Temperature : Temperature conditions as obtained at higher elevations in the Nilgiris, seem to be very suitable for pyrethrum. In Ootacamund, which is situated at an elevation of 7,525 feet, the mean monthly temperatures show very slight variations from 54 degrees F in the months of December and January to 61 degrees F in the months of April and May.

CULTURE

Nursery technique : For a nursery site, it is desirable to select a well drained gentle slope close to a perennial source of water. The ground is thoroughly dug up two or three times to remove all weeds and grasses. In the Nilgiris, Kikyu grass *(Pennisetum clandestinum)* is a very troublesome weed and particular care is taken to remove all bits of the roots, which if left will sprout up very rapidly. Standard nursery beds of 40 feet length, 4 feet width and 3 to 4 inches height are then formed and 60 to 70 pounds of well decomposed farm yard manure are mixed thoroughly with the soil. The sides of the beds are protected with brushwood. Paths one foot in width are left between the nursery beds for watering the beds, removing the weeds, and other operations. After the beds are formed, they are watered for 3 or 4 days so as to remove any weeds that may be remaining in the soil, by allowing them to germinate. Pyrethrum seedlings are highly susceptible to weed competition and before the seeds are sown, all the weeds must be removed scrupulously.

Three to four ounces of seeds are sown per standard bed. Pretreatment of seeds with cold water for a period of 6 to 12 hours has given good results in the Nilgiris. After sowing, the seeds are covered with a thin layer of earth and pressed gently, and a layer of grass 2 to 3 inches thick laid directly on the soil. In areas, where white ant damage is serious, the grass cover is raised a few inches on trellis supported by forked sticks. Grass containing seeds should be strictly avoided as they may germinate and choke the pyrethrum seedlings quickly. The beds should be watered daily from a very fine rose can. Removing the grass before watering is advisable and the grass may be replaced after watering is done. Germination starts in about 8 days and is complete in about *15 to 21 days. As soon as germination is more or less complete,* the grass cover should be removed. The young seedlings are highly susceptible to "damping-off" and if any sign of this is observed before the germination is complete, the grass cover should be removed and sun-light allowed to fall directly on the seedlings. The seeds are usually sown in the month of September or October and the seedlings transplanted in the following April or May. As soon as the seedlings have put forth four or five leaves, if the stand is too thick in the nursery beds, the seedlings should be pricked out carefully and transplanted in vacant beds kept ready for this purpose at an espacement of 3 x 3 inches. This will not only prevent "damping-off" in the beds but also produce seedlings of uniform size and good vigour. On an average, one standard bed of 40 x 4 feet will give 2500 good seedlings.

Splits versus seedlings: Pyrethrum is propagated either by seed or from splits from older plants. It cannot be stated definitely which one of the two methods is better. One significant advantage in planting splits is that they establish themselves much quicker, especially if the planting is followed by a spell of wet weather. If seedlings are used under such conditions, they may be covered with soil and silt, washed down from the slopes, and have very little chance of establishing themselves. Moreover, splits have the advantage of coming into production earlier than seedlings, and producing higher yields during the first year. Seedlings are however able to survive much better than splits in dry

weather. The advantages of vegetative propagation by splits have not been properly evaluated.

Preparation of land: As pyrethrum is a plantation crop and stays in the ground for several years, it is desirable to clean the land thoroughly of all weeds particularly grass before planting is done. The land is therefore ploughed or forked two or three times and the clods are broken. It should, however, be borne in mind that the soil should not be broken down to a fine tilth, because during further operations in the fielb such as picking and weeding, the constant trampling of human feet may result in the soil being compacted into a hard mass. Sloping ground is well terraced, or graded contour trenches are formed at suitable intervals. In the Nilgiris, in addition to graded contour trenches, uncultivated grass belts of 5 to 10 feet width are left alternating with cultivated strips which are 11 to 30 feet in width to prevent any soil wash. The earth in the forked strips is formed into ridges 6 inches high and 2½ feet apart after being allowed to weather for about two months. Seedlings are planted in the ridges formed.

Espacement: It cannot be stated definitely which espacement is the best as different espacements have been adopted in different countries. In the Nilgiris, experiments have been conducted with the following espacements in feet.

(a)	2½	between rows and	2½	in rows.
(b)	2½	do.	2	do.
(c)	2½	do.	1½	do.
(d)	2½	do.	1	do.
(e)	2	do.	2½	do.
(f)	2	do.	2	do.
(g)	2	do.	1½	do.
(h)	2	do.	1	do.
(i)	1½	do.	2½	do.
(j)	1½	do.	2	do.
(k)	1½	do.	1½	do.
(l)	1½	do.	1	do.

The data collected, when analysed statistically, have shown that treatment (b), i. e. 2½ ft. between rows and 2 ft. in rows, has given significantly the best results. However, in the older plantations started in 1943 and 1944, closer

espacement of 1½ ft. between plants and 2 to 2½ ft. between rows was adopted. It has been also observed that plants grown too close together do not yield well, especially after the second year. From the experience gained in the Nilgiris during the last five years, it may be stated that an average bush grows to a circumference of about two feet and it is therefore advisable to plant seedlings at this distance from each other. The 2½ ft. width between the rows will not only reduce the nursery and planting costs appreciably but also enable easier weeding. In slopes and in places where the soil is highly erosive, it is however advisable to plant seedlings at a closer espacement in the rows as this would form a continuous hedge and prevent soil wash. On the whole each area must be judged on its own merits and suitable espacement determined.

Time of planting: In the Nilgiris, as a result of numerous experiments conducted to determine the best time of planting, it has been found out that April planting immediately after the premonsoon showers gives significantly the highest yield per acre. As a general rule, planting should begin when the ground is wet, and the weeds have been germinated and either removed or harrowed in. On sloping ground, the planting lines should follow the contours. The planting lines should be parallel to the top contour so that the short lines end in the lower contour. As soon as the first premonsoon showers are received between April and May, seedlings with atleast 3 pairs of leaves are carefully lifted from the nursery beds and taken to the planting area in baskets. It is advisable to discard those seedlings showing swellings on the roots as such swellings are characteristic of eel worm attack. The discarded material should be either buried deep or burnt. Care should be taken to see that the root system suffers from the least possible damage. The planting holes must be dug deep enough to receive the whole root system without the roots being twisted upwards. After the roots have been inserted as straight as possible, the soil must be pressed firmly around them without leaving any air space. If the soil is too wet, it should not be pressed too hard as it would form a cake and harden in a dry spell and might lead to the death of the plants. In fact, in very

wet weather, it is better to defer the planting for a few days. Deep planting should be avoided as it results in a significantly lower yield. Experiments conducted in the Nilgiris have shown that it is advantageous to cut back newly planted pyrethrum when about three stalks have developed, because this encourages the seedling to shoot forth with great vigour. The seedlings should establish themselves under normal climatic conditions in about a month's time. If gaps appear in the lines, they should be immediately filled up with either seedlings or splits.

Tending: Regular weedings are necessary for reasons already explained. The common weeds found in the Nilgiris are *Eupatorium glandulosum*, *Helichrysum* spp., *Vernonia* spp., *Hypericum mysorensis*, *Eulex europeus* and *Cytisus scoparius*. The common grass as already indicated is Kikyu. Weeding is best done by handpulling at regular intervals and before the plants flower.

Normally two weedings are done during the year of planting; the first weeding early in July and the second weeding after the South-west monsoon is over i. e. by September-October. The weeds after being pulled out are heaped in the trenches between ridges so as to form a mulch. From the second year onwards, it is necessary to do three weedings a year, the first weeding in July, the second in September–October, and the third in June. If found necessary, a fourth weeding may be done between February and March.

In the past, forking the soil between planting lines was done, as it was believed that the soil working would encourage the growth of the plants. Subsequent observations in the field and the reports from Kenya have however shown that the root system of pyrethrum should not in any way be disturbed if the plants are to grow satisfactorily. The soil working is therefore not recommended now. Weeding operations should also be done carefully to avoid damage to the root system.

Manuring: In Kenya, it has been estimated that a record crop of 1,000 pounds of dry flowers per acre deprives the soil of only 17 pounds of nitrogen, 25·75 pounds of potash and 5·75 pounds of phosphoric acid. Experiments

conducted in the Nilgiris have shown that pyrethrum does not readily respond to manuring. In Kenya, application of small quantities of phosphates in and around the planting holes is reported to be giving very good results.

PICKING

In the Nilgiris, the bushes start flowering in about 6 to 9 months after planting, depending on the premonsoon showers. If the planting is followed immediately by a dry spell of weather, the plants may take as much as nine months to flower, but if the weather is normal in April and May, and four or five good showers are obtained, flowering starts even after four months. The yield of flowers during the first year, as indicated earlier, is comparatively low and it may vary from 50 to 100 pounds of fresh flowers per acre. The yield is significantly more during the second year, and the peak production is reached during the third and fourth years. Thereafter, it falls down.

The keeping quality of pyrethrum flowers and the *pyrethrin* content depend entirely on the stage at which the flowers are picked. Immature flowers and over-mature and full blown flowers contain less pyrethrin, and it is therefore absolutely necessary to pick the flowers at the correct stage, which is when the flowers have atleast 3 to 4 rows of disc florets open. People engaged in this work very soon learn to recognise the correct stage at which the flowers are to be picked. From the second year onwards, picking is done at the interval of 7 days in the Nilgiris. In Kenya, the flowers are picked at intervals of 10 to 14 days, in Dalmatia once a week, and in Japan at intervals of 14 to 18 days.

The flower-heads are picked from the stalks using the thumb and index finger by a gentle jerk without causing any injury to the plants. Although it is a skilled operation, the boys and girls who are engaged in this work soon learn the technique, and they are able to do the work very quickly. The stalks contain comparatively little pyrethrin and the labour engaged in picking should be instructed not to include any stalks while picking flowers. An average boy in the Nilgiris can pick anything from 25 to 40 pounds per day and

an adult may be able to pick 50 to 60 pounds of flowers. The flowers are usually carried in baskets so as to allow aeration. If the flowers are gathered in a closed vessel and compacted, there is the risk of the pyrethrin getting decomposed due to the heat produced.

DRYING

The flowers may be dried either in the sun or in specially constructed driers in which hot air is made to circulate at a fixed temperature between trays containing the flowers. Sun drying will usually take about 4 days and is possible only in dry weather and if the acreage is small. During wet weather, and if the quantity of flowers picked is large, it is necessary to have kilns for drying.

In the case of kiln drying, the fresh flowers should be spread out on trays as soon as they are collected, to avoid heating and should be put into the drier without any undue delay. It is advisable to have plenty of trays for this purpose. The type of tray used in the Nilgiris consists of a frame 6 ft. by 3 ft. and 3 to 4 inches deep, with a wire mesh gauze, through which the dried flowers will not pass, as the bottom. Each tray can hold about 30 to 40 pounds of fresh flowers. Drying in a kiln should be done at 130 degrees F. Higher temperatures will lead to decomposition of the pyrethrin, and particular care should be taken to see that the temperature in the drier does not rise above 130 degrees F. A thermometer is kept in the drier for this purpose and readings at regular intervals are taken to ensure proper drying without the risk of the pyrethrins getting decomposed. In the Nilgiris, a drier can dry 1,000 pounds of fresh flowers at a time in about 8 to 10 hours.

In Japan, the loss in weight on account of drying is estimated to be 65 to 75 per cent, and in Kenya it is about 70 per cent, and in the Nilgiris, it varies from 72 to 76 per cent. Usually, it is reckoned that four pounds of fresh flowers will weigh one pound, when it is dried. After the flowers are thoroughly dried so that they could easily be crumbled between fingers, they are packed in gunny bags containing 55 to 60 pounds and despatched to consuming

centres. The flowers from the Nilgiris are chiefly despatched to the Government Kerala Soap Institute at Calicut and there it is made into pyrethrum extract.

CLEANING

The dried flower stalks should be regularly removed as otherwise the yield has been found to go down appreciably. In South India, these stalks are easily removed by means of a secateur or a pair of strong scissors. The dry stalks thus removed are kept in the trenches along with the weeds to form a mulch. It is advisable to do such cleaning atleast once in two months.

YIELD

The yield has shown very great variations in the Nilgiris. The statement below shows the average yield in pounds per *acre obtained in the Nilgiris between 1944–1945 and 1948–*1949.

Year	Area	Yield per acre	
		Fresh	Dry
1944—1945	1,400 acres	316	77
1945—1946	1,800 ,,	210	54
1946—1947	1,800 ,,	198	50
1947—1948	948 ,,	127	33
1948—1949	660 ,,	39	10

Although the average yield is significantly lower than in Japan, Dalmatia and Kenya, it may however be mentioned that certain fields have given an yield of 1700 to 1900 lb. of fresh flowers during the second, third and greater part of the fourth year of the rotation. The low yield in the Nilgiris can only be attributed to the faulty technique adopted in the past such as planting on flat ground, improper weeding and regular forking of the soil in between the plants resulting in the soil around the roots being washed away. Experimental plantations adopting improved technique such as ridge planting, careful weeding, and preservation of the soil have

given an average yield of 1450 lb. of fresh flowers during the second, third and fourth years. In future plantations, it can therefore be safely assumed that an average yield of atleast 1400 lb. of flowers per acre would be obtained.

In Japan, the yield varies from 300 to 1200 lb. of fresh flowers per acre, while in Dalmatia it varies from 155 lb. to 800 lb. In Kenya, where systematic and well planned research is being carried on to improve both the quality and quantity of pyrethrum, a record yield of 4000 lb. of fresh flowers has been obtained from certain experimental plantations. The average yield, however, varies from 1500 to 1600 lb. per acre. With this, the yield in the Nilgiris and Upper Palnis compares favourably.

PHYRETHRIN CONTENT

The flowers produced in the various fields in the Nilgiris have been analysed by the Research Officer attached to the Medical College, Madras, and the following table shows the pyrethrin content.

Name of the field	Pyrethrin content (Total pyrethrin) per cent
1. Hecuba	2·24
2. Hodgson's hill	2·49
3. Ree's corner	2·44
4. Sholur	2·26
5. Muthinad	2·29
6. Brookhampton	2·77
7. Mainalai	1·19
8. Jakuntha	1·93
9. Honnetalai	1·81
10. Kodanad	2·20
11. Newman	1·99
12. Tuneri	2·55
13. Honnabetta	1·59
14. Okkabetta	2 09
15. Ebbanad	1·43
Average	2·08

In Kenya, the average pyrethrin content is 1·4 and the highest is 2·1. Breeding experiments to evolve a high toxic strain of pyrethrum were started in several parts of Kenya as early as 1935 and they have already succeeded in producing a strain containing 2·67 percent of total pyrethrins. Splits from

this improved strain are being planted now to produce it on a large scale.

In Japan, the average pyrethrin content is 0·9 and it varies up to 1·2 percent while in Dalmatia it varies from 0·7 to 0·8 percent.

PYRETHRINS

Although pyrethrum has been known and used as an insecticide for more than 100 years, the active principles in it were not known till 1914. Several attempts were made upto 1910 to isolate the toxic principles in pyrethrum flowers. Between 1910 and 1915, Staudinger and Ruzicka carried out intensive researches and published a series of papers in 1924 considered as among the finest in the field of plant chemistry. As a result of their researches, they were able to isolate the toxic principles in pyrethrum consisting of two organic esters chemically represented by the empirical formulae, Pyrethrin I, $C_{21} H_{30} O_3$ and Pyrethrin II, $C_{22} H_{30} O_5$. The two compounds are distinct and each has a pronounced insecticidal effect. The ratio of Pyrethrin I to Pyrethrin II in the flower varies between 1 : 0·65 and 1 : 2·42. Pyrethrin I has been found to be slightly more active than Pyrethrin II as it kills roaches in 1 : 10000 solution in 10 to 20 minutes, while the latter takes 20 to 40 minutes at the same dilution. Both the pyrethrins are highly unsaturated in the acid and alcohol parts of the molecule and therefore unstable. Their toxicity has been found to be dependant not only on their composition but also on the spatial arrangement of the molecule, and Gnadinger considers that the commercial production of synthetic pyrethrin is highly improbable. Gnadinger and Corl ascertained the distribution of pyrethrins in the different parts of the flowers as follows :

	Composition of flower by weight per cent	Percentage of total pyrethrin
Achenes	34·2	92·4
Receptacles	11·3	3·5
Involucral scales	11·5	2·0
Disc florets	25·8	Trace
Ray florets	17·2	Trace

One of the most remarkable features of the pyrethrins is the rapidity of their action on the insects to which they are toxic. The action of the pyrethrins on the insects has been described variously by research workers. The concensus of opinion, however, is that they have a direct action on the nervous system. In most species of insects, the effect is that of a violent irritation causing paralysis followed by death.

INSECTICIDAL VALUES OF PYRETHRIN

There is no doubt that compared to the various natural and synthetic insecticides available in the world, pyrethrum is among the best. Its greatest advantage is that in certain concentrations, it is transient in its effects. While completely effective against the pests which it is desired to control, after a few hours, the pyrethrins become oxidised and are therefore harmless to the useful pollinators and predatory insects. In this respect, pyrethrin has a decided advantage over any other insecticide particularly D.D.T. which has a residuary effect for a period of three to six months, and along with the harmful insects, may kill the useful ones such as the pollinators, predators and parasites. Besides this, while pyrethrin is highly toxic to cold blooded animals, it is absolutely harmless to warm blooded animals and can therefore be used in controlling insect pests that attack food stuffs and domestic animals such as cattle. The complete control of grain weevil, which causes very great damage has been possible with pyrethrum powders. Similarly in the control of plague, and pests in water-works and sewage plants, and in anti-malarial control, pyrethrum has been found to be an invaluable insecticide. The control of mosquito larvæ with a spray emulsion containing 4 percent pyrethrum extract, 63 percent of kerosene, 3 percent of liquid soap and 30 percent of water has been found to be very useful and effective.

PREPARATION OF PYRETHRUM EXTRACTS

Both Pyrethrin I and Pyrethrin II are soluble in mineral oils. This property has been taken advantage of in the preparation of the various pyrethrum extracts. For general purposes, pyrethrum extracts are prepared with refined

kerosene oil. Pyrethrum flowers are macerated with refined kerosene in a tank equipped with an agitator using about one pound of flowers to each gallon of oil. The maceration is prolonged for a few days to several weeks, the longer the better. The mixture is then pumped through a filter press. Extracts containing higher concentration of pyrethrin may also be prepared by the same process using up to a maximum of four pounds of flowers to one gallon of oil. Horticultural sprays are usually made with alcohol or acetone. Commonly, the pyrethrum extract using 10 pounds of dried flowers and 13 gallons of kerosene is prepared for normal household purposes. This extract will contain 0·1 percent pyrethrins which conforms to the normal standard. Such a spray can be used effectively against all common flying insects such as house-flies, mosquitos, moths and also against cockroaches, bed-bugs, etc. In horticultural operations, when a liquid spray is liable to damage the plants, an inert powder or filler like gypsum or talc is mixed with pyrethrins dissolved in a volatile oil; for example, 8 percent kerosene extract of pyrethrum containing 2½ percent of pyrethrins with 90 percent gypsum is mixed in a ball mill to ensure a thorough mixing. Such insecticidal dusts are sprayed from aeroplanes in advanced countries. In Germany, the dust is used to control the gypsy-moth in the extensive pine forests. By using suitable dusters, the dust can be sprayed on coffee and tea to control the pests.

ROTATION

The 1943 plantations in the Nilgiris were yielding even in 1948–'49, and in certain fields the fall in the yield was not at all appreciable. Generally speaking, there was a significant fall in the yield during the fifth year. It is therefore impossible to fix a definite rotation for pyrethrum as it depends entirely on the locality factors of a particular field or area. However, it is altogether incompatible with good farming to leave pyrethrum crops in the ground for too long a period and use the same area continuously. Diseases and weeds can only be controlled, if a different type of crop is rotated with pyrethrum. In Nilgiris, a suitable rotation will be six years, out of which 3½ to 4 years will be under

pyrethrum and the rest 2 to 2½ years under cereals such as wheat, oats, barley, rye or suitable fodder grass.

PESTS, DISEASES AND INJURIES

Not much attention has been paid to pests and diseases of pyrethrum in the Nilgiris, and very little data are therefore available. Kenya reports the eel worm, thrips, and root-rot among the pests and diseases.

Severe frost may cause serious damage to the bushes especially in the early stages. In the Nilgiris, the early frost in October causes very heavy damage to young plants, but the older plants that are more than 2 years old seem to stand the frost well.

ECONOMICS

In working out the cost of cultivation and returns at costs and prices prevailing at the time of writing, the nett profit is estimated to be Rs. 780/- per acre for the full rotation of six years or Rs. 130 per acre per annum. The above estimates are based on an yield of 100 lb. of fresh flowers per acre in the first year, 1000 lb. in the second year, 1400 lb. in the third year, and 1300 lb. in the fourth year.

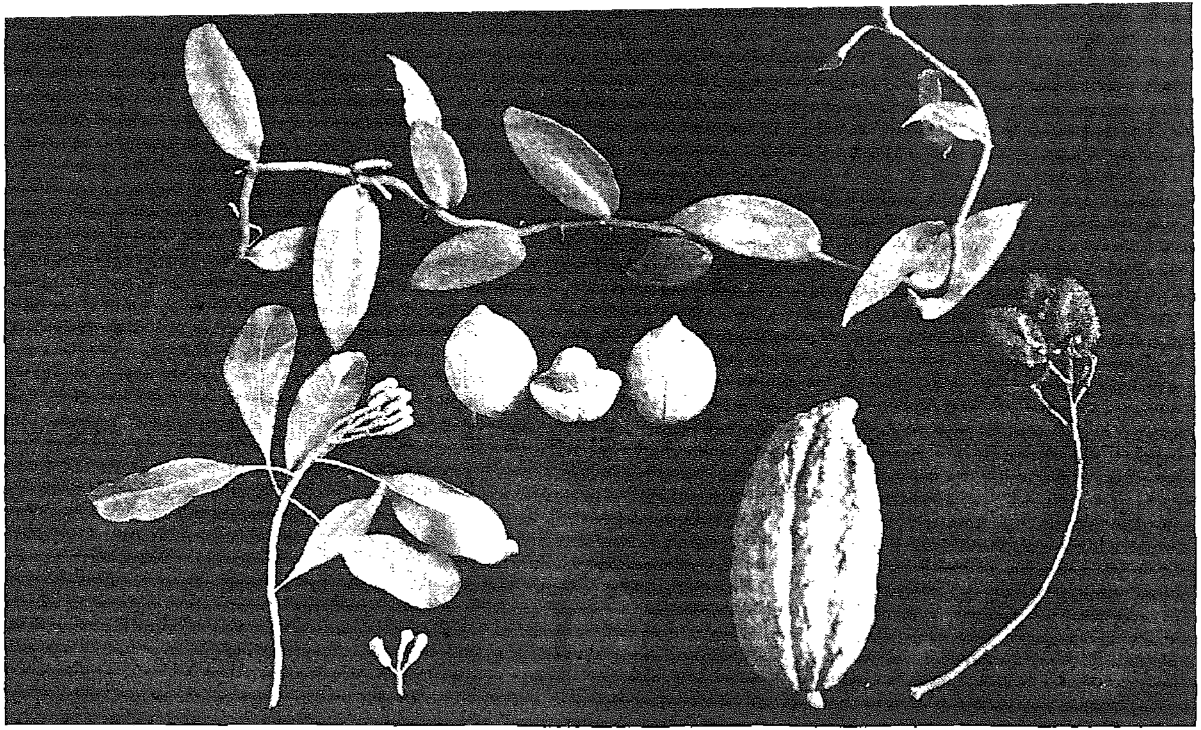
RESEARCH

Although the pyrethrin content of the Nilgiri flowers is the highest in the world, the yield of flowers per acre is miserably low. As against an average of 450 pounds of dry flowers per acre in Kenya, it is only 70 pounds per acre in the Nilgiris. As already mentioned, certain fields have given upto 1900 pounds of fresh flowers per acre and in the experimental plots an average yield of 1450 pounds has been obtained. This clearly indicates that a considerable amount of research work has to be done to improve the yield by modifying the present techniques. In Kenya, a separate Pyrethrum Board has been created and systematic and well-planned research into the various aspects of pyrethrum cultivation has been going on since 1935. They have already

succeeded in evolving a high yielding strain with high toxicity giving a yield of 4000 pounds of fresh flowers per acre and a pyrethrin content of 2·67 per cent. Similar research in Nilgiris is also necessary, if pyrethrum cultivation has to be taken up seriously.

CONCLUSION

Malaria is one of the worst scourges in India, and it has been estimated that on an average, a million human lives are lost every year besides sapping the energy of countless number of people. A well-planned anti-malarial control has therefore become vitally necessary and the production of pyrethrum is of primary importance. Besides malaria, the grain weevil and various other insect pests are causing incalculable damage to our food crops. According to one authority, the grain weevil alone is responsible for the loss of more than two million tons of food per annum. The importance of this at the present moment of acute scarcity of all kinds of food can easily be understood and realised. In the Nilgiris, almost optimum conditions for the cultivation of pyrethrum are available, and the cultivation of pyrethrum is a profitable occupation. Considering all these facts, the necessity for large-scale cultivation of Pyrethrum cannot be over-emphasised.



Upper : Vanilla vine.
Lower : Clove twigs with buds, nutmeg and mace, cacao pod, annatto pods (dye).

14. SPICES AND CONDIMENTS IN THE NILGIRIS

Spices and condiments are the very breath of life in India, and enter into every kind of food of the people and every kind of home medicinal preparations, in one form and another. Besides this, the spices of India command a great export trade; and according to *the Hindu* of June 3, 1952, the dollar income from pepper alone from 1948 to 1951 was $ 95,097,260, being greater than from tea whose income duringthe same period was $ 67,385,497. In 1951, this difference was even more noted, pepper bringing an income of $ 34,162,480, compared to $ 15,692,126 from tea. About nine varieties of spices of Indian origin have a good market in the U. S. A., and India supplies spices to that country worth 45½ million dollars out of 58,477,000 dollars spent by Americans on import of spices. These examples are mentioned to indicate the contribution of spices to the national wealth of the country.

But, India also imports large quantities of spices like cloves, nutmeg and cinnamon from other countries e. g. Zanzibar, Ceylon and Java. In this respect, India should try to make itself self-sufficient, and certain zones of the Nilgiris seem to offer ideal conditions for their expansion, and much work needs to be done in further research and expansion in these crops on the Nilgiris.

The following notes are of spices and condiments which deserve consideration as having been suitable for the Nilgiris.

CLOVE

Eugenia aromatica, Baill. *(Caryophyllus aromaticus,* Linn. *E. caryophyllata,* Thunb. *Jambosa Caryophyllus,* Ndz). Myrtaceae.

Clove is among the most important and valuable spices. The Clove of commerce is the dried, unopened flower bud. The clove tree is a native of the Moluccas, and is a conical shaped and symmetrical tree. The world's supply of clove comes mainly from Zanzibar, and to a much lesser extent from Madagascar; and India has been the most important customer of the Zanzibar cloves.

The clove trees are seen to grow very well upto 3000 feet elevation on the Nilgiri slopes. They are in fact in very fine condition in the Kallar-Burliar zone (1400–2500 feet). There are trees over 75 years old in Burliar, which have till recently been yielding well and are showing only now, signs

of decline. It is said that in the Pemba island of Zanzibar, many trees among the first introductions in the first quarter of the 19th century, are still bearing.

Among the requirements for proper growth of cloves on these hill slopes is an elevation of 3000 feet and less, and an annual rainfall of 60 to 120 inches.

The cloves are propagated generally by seeds. They are first sown in a nursery or in baskets or pots. They take first of all 5 to 6 weeks for germination, not all seeds germinate, and after germination, they grow very slowly. When they are about 18 to 24 inches high, and have started branching, they are transplanted, giving a spacing of about 25 feet between plants. It is desirable to irrigate the young plants and also grown up trees, as there is good response to irrigation. The trees begin to bear when they are 8 to 10 years old, and the yield increases till about 20 years old, when the maximum is reached. In Burliar, on the Nilgiris, 5 pounds of dry clove are obtained on the average per tree per year, but individual tree yields of 20 pounds have also been obtained.

The flower buds are picked usually from February to May on the Nilgiris. At the time of picking, the closed buds have attained a pinkish shade outside, and have a slightly cylindrical base, with a plump, ball-like unopened corolla, around which is the four teethed calyx. These buds are picked by hand and dried in the sun, till the buds are completely dry and darkish brown.

Problems connected with cloves are the usually low percentage of germination of seeds, slow germination, slow growth in the nursery and the difficulty in the harvesting of produce. Well grown trees are too tall to properly pick the flower buds and it is estimated that 30 to 35 percent of the crop is lost due to the height difficulty. Regarding propagation, Kallar Fruit Research Strtion has tried inarching on its own stock, which has given the station a success varying from 60 to 100 percent.

With their fine aroma and flavour, cloves have many uses, in both whole and powdered state, as a culinary spice; and one of its remarkable features is its flavour blending with both sweet and savoury dishes. They are used for flavouring pickles, ketchup and sauces. It has also its medicinal uses. Many use it for perfuming their breath. Often it is also used for perfuming the air in the rooms.

The essential oil called clove oil distilled with water or steam from the cloves or from the leaves and unripe fruit, "mother or cloves", or broken cloves and stalks, has even a greater number of uses. In medicine it is used as antispasmodic, antiseptic, and counter irritant. (See article on "Medicinal Plants of Nilgiris.") It is a cleaning agent in histological and microscopic work. It is extensively employed in perfumes and scented soap.

From the clove oil itself is extracted eugenol, the chief constituent of the oil, which is used as imitation carnation in perfumes and for the manufacture of artificial vanilla.

NUTMEG AND MACE

Myristica fragrans, Houtt. (*M. Moschata*, Thunb. *M. officinalis*, Linn. f. *M. aromatica*, Lam.) Myristicaceae.

Myristica fragrans is a native of the Moluccas or Spice Islands, and is now spread over the tropics of both hemispheres. The chief sources of

this crop today are Indonesia, Grenada in the West Indies (where the trees are in many cases interplanted with cacao), and to some extent Malaya.

The *nutmeg* of commerce is the ovoid kernel which is hard and brown enclosing which is a thin brittle shell. Surrounding this shell is a ruminated aril, scarlet in colour, which furnishes the *mace* of commerce. Surrounding the aril is the thick fleshy pericarp. The ripe fruit as a whole is nearly globular in shape, but may vary to a pyriform shape.

Myristica fragrans was introduced into Nilgiris about 80 years ago, in Burliar (2500 feet). Even now in Burliar, there are bearing trees which are more than 75 years old. In South India, Courtallam in Tinnevelly District, and the Burliar zone in the Nilgiris are the chief places where nutmeg is grown, and together with about 500 trees, possess on an estimate about one-third of the total number of trees in India. The trees in Burliar are in very good cropping condition, and nutmeg deserves consideration for further expansion in suitable zones of not only the Nilgiris but other hill slopes of India with suitable natural conditions for the growth of nutmeg.

It grows best under humid tropical conditions, from sea level to about 2500 feet elevation, with rainfall ranging from 60 to 120 inches. The soil in which the trees have been thriving well in the Nilgiris is fairly clayey with fair quantities of gravel. Lack of drainage seems to affect the trees adversely. They do not also stand too dry conditions or sandy soils.

Propagation is by seed. Fully mature fruits are collected, the husks of which are split and they are dried for a day. The seeds from these are sown with the shell in the nursery beds, in a moist shady corner; or pandals are erected to shade the nursery beds. Seeds take upto three months to germinate. When the seedlings grow large enough to handle, (about 6 months after sowing), they are transferred to pots, where they are allowed to grow for about a year. The seedlings are now planted in permanent situations, giving a spacing of about 25 feet between trees. Younger seedlings do not establish well. The seedlings have a taproot which is very easily injured in transplanting, and good care must therefore be taken in transplanting. In this connection, it must be remembered that usually nutmeg trees are dioecious, male and female flowers occurring in different trees. It takes 6 or 7 years before they flower, and there is no way of ascertaining the sex of the trees, before this period. Precious time and labour up to 7 years is thus wasted in the growth of non-productive male trees. It is reported that in Jamaica, nutmeg seedlings are grafted by approach with thin twigs of female trees as scion, to overcome the uncertanty and waste of time mentioned above. The Burliar Fruit Station has attempted inarching nutmeg on its own seedling and reports 60 to 100 percent success. This station is also investigating the rootstock possiblities of *Myristica beddomei*, and *M. attenuata*, wild species from Annamalais and South Canara respectively. It is also reported that in Burliar regarding the sex situation in the trees, they are of two types viz. pistillate and "hermaphrodite", the latter yielding only a small number of fruits, and a fairly high percentage of double nuts. It must be pointed out that old trees are known in literature to become monoecious and this situation is likely to have occurred in the old trees of Burliar.

To be sure of a pistillate trees in each hole, two seedlings should be planted per hole to remove the unwanted trees later. One male tree to 10 or 12 female trees is required for pollination purposes.

After planting out, the trees require in the first few years a medium shade. A good plan is to grow bananas around the pits, some time prior to the planting of nutmeg trees in pits. The bananas can be thinned out, as the seedlings grow bigger. Nutmegs can also be grown in cardamom and coffee plantations. Regarding other cultural operations, a mulch of dry leaves around the trees has been found to be beneficial in Burliar. Since nutmeg has a lateral root system close to the soil surface, digging the ground around the trees should be avoided as far as possible. Usually manuring has not been regularly done in Burliar.

In Burliar, presumably because of the higher elevation, the trees are slower in coming to bearing, taking about 12 years after planting, compared to those in Indonesia and Malaya where it takes about 8 to 9 years. From the time of flowering, it takes 6 months for the fruits to mature. In Burliar, fruits are collected almost throughout the year but the main harvest is from June to October and an annual average yield per tree of about 1300 nuts, yielding about 20 lb. of dried nuts and 2 lb. of mace is normally obtained. 4000 nuts and above have also been obtained per tree in some years.

In Burliar, a large portion of the crop is sold as green nutmegs. For separating the mace from nutmeg and preparing the dried products of nutmeg and mace, the best way is to sever with fingernail the point of attachment of the branching strips of mace at the top of the nut. The lace-like covering is then pressed flat with the hands, and the mace flattened out in this manner is spread in large trays, which are placed in the sun and left to dry The nuts are separately dried on mats. In Burliar, the dried nuts are stored without shelling in airtight containers. The mace when first dried is brittle and dark red. In three weeks, it is brownish yellow and in about siz weeks, it takes on a pleasing bright amber colour.

Nutmegs have been used for a long time as a culinary spice and also medicinally. Nutmeg is grated and used in the preparation of sweet dishes, puddings and custards. Fresh husks of the ripe fruits can be used for preparing a jelly. Pickles are also made with these.

An essential oil is also extracted for use in medicine in perfuming medicinal and toilet soaps and dental pastes, and flavouring chewing gums, chewing tobacco etc. At Burliar, from the leaves, about 0·5 percent of oil has been extracted, and this oil is under investigation as a weedicide.

Mace is considered as one of the most delicately flavoured of spices and is used with savoury dishes and in making pickles, ketchup and sauces. It is also used in confectionery and with betelnut powders.

CINNAMON

Cinnamomum zeylanicum, Nees. *Lauraceae.*

The cinnamon tree is a native of Ceylon which has been from the beginning the chief source of the world supplies of cinnamon. The tree is now grown in Southern India, Burma and parts of Malaya, West Indies and South America. But the quality of Ceylon cinnamon is still considered to be superior to any other cinnamon in the world. Regular

cultivation of cinnamon in India is said to have commenced about 180 years ago, with 500 acres in Anjarakandy near Cannanore in Malabar. Subsequently they were planted in parts of Nilgiris. Cinnamon seems to fare best in alluvial sandy soils, in a humid tropical climate with an average rainfall of not less than about 80 inches. On the Nilgiri hill slopes, it can be grown up to an elevation of 2,500 feet.

The proper method of growing cinnamon for commercial production of cinnamon is to grow the trees in the form of bushes. Seeds are best sown in situ in a circle, with a diameter of about four feet, giving about nine inches spacing between the plants. Such circles or circular clusters are placed about 8 to 10 feet apart. About three weeks are required for the seeds to germinate. In about 2 years, they attain a height of 6 to 10 feet and a thickness of ½ to ¾ inch. At this age, at a period when the growth is active and the bark can be easily peeled, the shoots are cut to the ground. The bark is then peeled off in strips and heaped and covered with sacks for a day, to permit a slight fermentation. The outer skin of the bark is scrapped off and the bark is partially dried in the shade for a day or two, when the bark contracts into *quills*. These are then finally dried in the sun and at this stage, the quills are of a pale brown colour, and are ready for packing for the market.

The trees are left to coppice and every two years, cuttings can be taken. The yield of quills increases till about the tenth year when the maximum is reached. Average yield varies from 50 to 100 lb. per acre.

The Burliar Fruit Station has a few well grown cinnamon trees, which are being used as a nucleus for seed production and distribution to the public, for further multiplication.

The "Chips" or pieces of waste bark are used for distilling bark oil. Oil is also extracted from leaf, which is comparatively inferior. Oil of cinnamon is used in candy, gum, incense, dentifrices, and perfumes. It has medicinal uses as carminative, antiseptic and astringent.

PEPPER *(Black Pepper)*

Piper nigrum, Linn. *Piperaceae.*

Pepper has been from time immemorial one of the most important spices in the world, particularly in India. This plant is indigenous to India or the Indo-Malayan region. Black pepper of commerce is the dried fruit of *Piper nigrum* or pepper vine, which is a perennial climber, and is cultivated as a plantation crop, mostly on both sides of the Western Ghats in India, particularly in Travancore and Malabar. In the Nilgiris, it is grown mostly in the Wynad–Gudalur zone, almost solely on shade trees for coffee, upto an elevation of 3,000 feet. This zone meets the requirements of the crop with regard to climate, being humid-tropical and having a heavy rainfall. According to the Government statistics pepper occupied 119 acres in the Nilgiris in 1949–1950.

The propagation of pepper is by cutting of the vines, varying from about 1½ feet upwards to about 2½ feet, planted at the rate of two to three to each tree on which the vines are to be trained It is preferable to choose the cuttings from the terminal portions of the most productive vines. Dadap (*Erythrina lithosperma*), Silver oak (*Grevillea robusta*), and Jack *(Artocarpus integrifolia)*, grown as shade trees for coffee on the lower

slopes of the Nilgiris form the general standards for these pepper vines. Good sheltered valleys are most preferred for the vines. The vine after planting grows rapidly, attaining about five feet after the first year. After 3 years, it begins to bear crops. Full bearing is reached in the sixth or seventh year. The picking of fruits (*berries* or *pepper corns*) commences as soon as here and there quite ripe berries are seen with their beautiful orange colour. Pepper is gathered by nipping off the *clusters of berries as a whole*. These clusters are spread on a clean floor or mat; the berries are then freed from their stalks by trampling, and dried in the sun for about a week, when the green outer skins turn dark, shrunken and wrinkled. This is the *black pepper* of commerce and is marketed in this form. *White pepper* is prepared from berries which are more ripe and turning yellow. These berries after being freed from the stalks are soaked in water overnight and then heaped up to undergo slight fermentation. The outer skin and pulpy layer are rubbed off between hands, after putting them in water, and the resulting white and clean berries are dried thoroughly in the sun to form the white pepper of commerce. This is mostly for the domestic use of the grower. 2 to 3 lb. of cured pepper is considered a good average yield per bush. Yields increase comparatively on bigger trees with several vines spreading over individual trees.

Pepper owes its aromatic odour to a volatile oil and its pungent taste to an oleoresin. It also contains an alkaloid. Pepper has a cooling effect and stimulates the flow of saliva and gastric juices. It has numerous culinary uses, and in Indian houses, it has several medicinal uses. The alkaloid in pepper is a source of synthetic heliotrope. The United States is the biggest market for pepper from India.

NILGIRI PEPPER

Piper schmidtii, Hook. f. *Piperaceae.*

This is the wild pepper of Nilgiris, growing in the sholas around Ootacamund, Coonoor and similar elevations above 5,500 feet, and is popular as spice and condiment among the indigenous population on the higher elevations of Nilgiris. This pepper has pungency similar to that of the common pepper and the plant is distinguished from *Piper nigrum* among other things by its "oblong or angular bracts, fitting close between the berries, with margin free all round" as against the "bracts rounded, free of the spike along their upper edges only and attached to it at the base and sides by decurrent margins" in *P. nigrum*. The female spikes are 2 to 3 inches long.

The sholas around Kotagiri have also got another wild pepper, *Piper brachystachyum*, Wall. with circular bracts, attached by the middle, with their margins free all round, with female spikes only ¾ inch long.

CARDAMOM

Elettaria Cardamomum, Maton. *Zingiberaceae.*

Cardamom plant is a native of the moist forests of South India and is cultivated chiefly in this region and in Ceylon. It has however spread to some extent in other tropical countries particularly Eastern Archipelago and Java. The fruits and seeds of the plant form the cardamom of commerce

It is a herbaceous perennial growing from "6 to 12 feet in height, with long lanceolate leaves with sheathing bases," and strong, creeping underground rhizomes. Flowers are borne in racemes, and are white, with a blue and yellow lip. The fruits are triangular or ovoid capsules containing a number of small brown angular seeds, which have a delicate flavour.

In South India, cardamom is cultivated in the regions all round the Western Ghats, extending in the north to the hill tracts of North Kanara and Konkan, and in the south to Travancore. Cardamom requires for its proper growth an elevation of 2,500 to 4,500 feet above sea level, a heavy rainfall of 80 to 150 inches per year, (higher the better), shade and mulch such as are furnished throughout the year by trees of ever-green forests, and good protection from wind. Some areas of the Nilgiris, on the westernside as a part of the Western Ghats, offer natural scope for the cultivation of cardamoms and a few planters have made a success of the cardamoms. Some cardamom is also grown in the Burliar zone.

Propagation is by division of the crowns or rhizomes or by seed. Seeds take 2 to 3 months to germinate. Under favourable conditions, the first crop can be obtained in the second or third year from planting; but full bearing is only in about the fifth year. The plants have a tendency to bear all through the year. Fruits are picked about once in a month. Fruits should be three quarters ripe at the time of gathering, as ripe capsules are likely to split and disperse seeds on the plant. The harvested fruits are dried in the sun.

Four important varieties are known in cardamom viz. (1) *"Malabar", (2) "Mysore", (3) "Ceylon", (4) "Munzerbad". Of* these the "Mysore" variety is best suited for higher elevations and is known to withstand exposure and winds better. The Mysore variety yields about 50 to 100 lb. of dry capsules per acre.

Cardamom is one of the most widely used spices in India in both sweet and savoury dishes. In Hindu festivals and ceremonial occasions, it has a great importance. The Western Nations use it widely for flavouring purposes in confectionery. In Indian medicines, it is famous as an aphrodisiac, and is used with masticatories and for sweetening the breath. In European medicines, it is used in flavouring beverages.

* * * *

There is one other important plant in this group which deserves greater attention on the Nilgiris i. e. the vanilla, *Vanilla planifolia*, Andr., a climbing orchid, from which is obtained the favourite flavouring material, *vanilla*. It requires a humid tropical climate, and grows in elevations between 2,000 and 4,000 feet, with an annual rainfall of about 100 inches, and a rich soil with plenty of humus, in situations which are moderately shady. Certain commercial concerns have made a success of growing vanilla profitably in Wynad. The Kallar and Burliar Fruit Stations on the Nilgiris have been paying more attention to the growing of this in recent years. The vine requires standards for being trained; and such trees as anatto, *Bauhinia*, cashewnut, and silver oak are suitable for this purpose. The vines are propagated from cuttings 3 or 4 feet in length, planted against the supports. In two to three years after planting, crops may be obtained. Under cultivation it is absolutely essential to fertilise the female flowers artificially by hand pollination,

as otherwise there will be no fruit set. The smooth cylindrical pods can be picked when a slight yellowing appears at the ends. The pods are cured to develop the flavour. Curing is done by a sweating process, leading to the conversion of glucoside by enzyme action into a crystalline substance, vanillin, which possesses the characteristic odour and flavour. Curing takes about two weeks.

Besides the above spices, *garlic* is grown in about 178 acres around Coonoor and Ootacamund after a crop of irrigated potatoes in the villages, in richer soils; *ginger* is grown in about 163 acres around Gudalur and has only in recent years become popular with the farmers, because of the high prices which ginger began to command; *chillies* are grown in about 85 acres, *coriander* in about 58 acres, and *turmeric* in a very small area, in lower elevations. But since these crops belong more exclusively to the plains and not so much to the hills, the lmited scope of this article does not permit more elaboration on these spices and condiments.

Sweet marjoram, peppermint, thyme and rosemary are among plants which can thrive at the higher elevations of the Nilgiris, and whose leaves are useful for spicing and flavouring culinary dishes. (For more particulars about these plants, please see articles on "Medicinal Plants in the Nilgiris" and "Essential Oil Plants in the Nilgiris").

15. ESSENTIAL OIL PLANTS IN THE NILGIRIS

Essential oils are contained in all distinctly aromatic plants, and occur in about 60 families, more prominently in *Compositæ*, *Labiatæ*, *Lauraceæ*, *Myrtaceæ*, and *Umbelliferæ*. The essential oils evaporate in contact with air and have a strong aromatic odour, and are thus distingushed from the fatty oils. It is ordinarily in the internal glands or in hair-like structures that the essential oils are secreted. But in such plants as wintergreen, the essential oil is not present in the plant but develops on hydrolysis of glucosides, by enzymes set free from the cells, when the plant tissue is ground up. Almost all parts of plants are known to yield essential oils, roots in the case of *vettiver*, wood in the case of *camphor*, bark in the case of *cinnamon*, leaves in the case of *eucalyptus*, flowers in the case of *rose*, fruits in the case of *orange*, and seeds in the case of *cardamom*.

The common method of extraction of essential oils from plant tissues is by *steam distillation*. In this case, the material, ground wherever necessary, is mixed up with water in a copper still and then heated till the water boils. The oil vaporizes and passes with the steam into a condenser, where on cooling, the oil collects as a layer on the surface of water and is removed and filtered. This method is used for example in the case of oils of eucalyptus, peppermint, and lemon grass. But in the case of flowers, the heat involved in steam distillation destroys the odoriferous principles and in such cases, *extraction process* is followed, in which low boiling solvents like petroleum ether and benzene are used, or maceration with fat is carried out. The maceration process is called *enfleurage*. Flowers like rose and orange are treated with a warm fat, while others with extremely subtle fragrance are macerated with a cold fat. For enfleurage, glass plates are coated with the fat. The flowers are placed on this and allowed to remain for several days, till the fat ultimately absorbs all the oil. The *pomade* as this is called is treated with alcohol to dissolve the oil.

While general principles of extraction of essential oils have been mentioned above, as far as the essential oil industry of the Nilgiris is concerned, steam distilation method is the only one commercially known and the distillation of eucalyptus oil from the blue gum, *Eucalyptus globulus*, is the most widely done. But the possibilities of growing successfully a range of useful essential oil plants on the Nilgiris have been demonstrated by the trials at the Government Botanic Gardens, Ootacamund and Sim's Park, Coonoor as well as in the Hill Fruit Stations and other Agricultural Research Stations on the Nilgiris. This article deals with the essential oil plants which have established themselves as an industry on the Nilgiris or proved themselves suitable in the trials mentioned above, or are found more or less growing wild on the Nilgiri plateau and worthy of exploration for essential oils.

EUCALYPTUS

Most of the species of *Eucalyptus* yield essential oils, each with individual characteristics. Australian workers have analysed oils from about 200 species and found that the oils "contain a variety of components, 50 of which have been well characterised". On the basis of the characteristic components, eucalyptus oils have been classified into three groups*:

1. Oils containing *cineole*, used for inhaling in the treatment of colds.

2. Oils containing a large percentage of *phellandrene* and less than 70 percent cineole. These oils are used mostly for solvent properties as in cleaning solvents and insect sprays.

3. Oils containing a large percentage of the terpenes of the acyclic type such as *citral*, its reduction product *citronellal* and the acetic acid of *geraniol*. Their low content of the camphor and mint like substances of the *Eucalyptus* in groups (1) & (2) above makes this third group of oils valuable to the perfume industry.

The "Nilgiri oil" as the eucalyptus oil from the blue gum on the Nilgiris is called, belongs to group 1 above, and workers in the Indian Institute of Science, Bangalore (Ramaswamy *etal*, 1946)† have shown the approximate analysis of the "Nilgiri oil" to be as below, in percentages:

1.	Lower boiling alcohols, aldehydes, ketones and acids	2·5
2.	Pinenes	24·0
3.	Cineole	62·0

* Haagen-Smit, A. J. Essential Oils–A Brief Survey of Their Chemistry and Production in the United States. *Economic Botany*. III: 71—83. 1949.

† Ramaswamy B. V., Narasimha Rao P. L., and Guha P. C. Essential Oil from *Eucalyptus globulus* (Nilgiris). *Journal of the Indian Institute of Science*. 28 A: 57—62. 1946.

4.	Pinocarveole	about	0·4
5.	Cuminaldehyde,	about	0·5
6.	Sesquiterpene alcohols		5·0
7.	Aromadendrene		1·0
8.	Phenols		0·3
9.	Residue (mostly aluminium oxide)	about	3·0

The same workers have determined the physical constants and other properties of the representative samples of the Nilgiri oil and have compared them with those of the Australian oil, and comparative data are shown in the table below:

		Nilgiri oil	Australian oil
1.	Percentage of oil	0·9—1·2	0·92
2.	Specific gravity	0·902	0·913
3.	Refractive index (n_D^{20})	1·4608	1·4663
4.	Optical rotatien $(a)_D$	+9·68	+8·4
5.	Acid value	6·3	—
6.	Saponification value	37·5	—
7.	Sopanification value after acetylation	92·2	—
8.	Cineole content	62·2	57·0
9.	Solubility in 70% Alcohol	Insoluble in 10 volumes	Soluble in 1½ volumes
10.	Phellandrene (B. P. test)	Negative	Negative

It is the opinion of these workers that by careful fractionation of the oil, the Nilgiri oil could be brought within the reach of the specifications of B. P. They also obtained chlorinated cineol fractions with apparently high disinfectant properties and considered them worthy of commercial exploitation in this country.

The first blue gum trees came into existence on the Nilgiris, with the introduction of eucalyptus into these hills in 1843, and the eucalyptus oil industry can be said to be approximately a century old in this hill district, which for a long time has been the main source of the oil for the country as a whole. This industry is a cottage industry on the Nilgiris, with about 300 country distilling units, employing nearly 3,000 people, and turning out normally about 30,000 lb. of oil annually. The distilling industry is carried on mostly by the *Ezhavas* from Palghat in the Malabar District, without much capital. The eucalyptus oil dealers advance money to the distillers who have to pay for the leaves to eucalyptus growers, and the dealers in return obtain the oil from the distillers. This industry of economic importance to the Nilgiri District had no organisation of any kind till recent years, and adulteration of the oil with kerosene oil by the distillers and with white oil from Burma shell or with turpentine by dealers, was practised to some extent. In 1950, however, the Eucalyptus Oil Merchants Association was formed for looking after the interests of the industry. In 1951, the Government also stepped in and ordered that the eucalyptus oil manufacturers should take out licenses. The Central Government which used to purchase a large quantity of eucalyptus oil from the Nilgiris, it is learnt, have cut down their purchases, and the oil dealers have not felt encouraged by this decrease in trade.

For purposes of preparing eucalyptus oil, the owners of eucalyptus plantations lease out their trees in alternate years on certain charges to be paid by distillers. The distillers strip these trees almost naked, except

for a tuft of leaves at the top. The Forest Department which operates the Government Eucalyptus Plantations has not permitted any such lopping of the trees for purposes of distillation of the oil, except just before the trees are felled, when they are about 20 years old. But noticing that lopping of trees in alternate years in private plantations has not resulted in very serious set-back to the trees, the Forest Department has recently contemplated attempting periodical lopping of trees, say once in four years, involving about five loppings during the life of the tree. The Eucalyptus oil is extracted in country stills by the steam distillation method, and the distillers economise the cost of fuel by using the dry eucalyptus leaf refuse and droppings.

Among other *Eusalyptus* species, *E. citriodora* has been coming into prominence in recent years for commercial manufacture of essential oil from it, *the oil of citriodora,* which has a clear white colour and a pleasing penetrating odour, and is particularly useful as a perfume for soap.

More than 35 species of Eucalyptus have been established on the Nilgiris, but the industrial possibilities of most of them for essential oil have yet to be investigated. The author had opportunity in a preliminary way to get leaf samples of about 14 species from Ootacamund and Coonoor distilled in country stills. It was found that on checking in one case with extraction under laboratory conditions, the country still used was found to be only 48 percent efficient. On this basis, the percentage of oil in the 14 species, with samples collected worked out as below:

E. amagdylina	..	1·3
E. Citriodora	..	0·9
E. Crebra	..	0·4
E. deanii	..	0·4
E. dives	..	0·8
E. eugonoides	..	0·5
E. longifolia	..	0·8
E. macrandra	..	0·6
E. macrocornys	..	0·3
E. punctata	..	0·5
E. regnans	..	0·6
E. robusta	..	0·1
E. smithii	..	0·6
E. tereticornis	..	0·6

It has been found by Australian workers that climate, season, soil and different stages of the plant, influence significantly the percentage of essential oils, and there are also differences between individual trees of the same species. Similar investigations are yet to be made on the Nilgiris and are worth making.

CAMPHOR

Cinnamomum Camphora, Nees and Eberm. and **Ocimum kilimandscharicum,** Guerke.

Camphor is valuable as raw material in several chemical industries, in the manufacture of photographic films, medicines, smokeless gun powder, incense etc. Large quantities of camphor are imported into India, and annual imports have gone up in some years to nearly 20 million pounds. India has very little raw material for the production of camphor.

and serious steps should be taken to investigate more thoroughly the possibilities of expanding our resources in this line, particularly on the Nilgiri hills, some zones of which seem quite suitable for the growing of the camphor tree, *Cinnamomum camphora*, Nees and Eberm., or the camphor plant, *Ocimum kilimandscharicum*, Guerke., either of which is a good source for the manufacture of commercial camphor.

The tree camphor, *Cinnamomum Camphora* has been introduced into the Nilgiris many decades ago, and fine specimens of the tree are seen in Sim's park, Coonoor (5,900 feet elevation) and Government Botanic Gardens, Ootacamund (about 7,700 feet elevation). A few trees were also introduced into the Burliar Fruit Station (about 2,500 feet elevation). Besides these, between 1937 and 1945, nearly 40 acres were put under tree camphor by Messrs. T. Stanes and Company of Coimbatore, in their Halacarai Estate near Coonoor. Experience shows that while the trees at Burliar and Coonoor flower, seeds do not develop properly on the Nilgiris as a whole. This matter requires deeper investigations. In Dehra Dun in Northern India, the trees are known to produce seeds properly, and seeds are available from the Forest Research Institute, Dehra Dun.

The tree is suited to a range of elevations upto 6,000 feet and more, but thrives better on the hill slopes such as those of the Nilgiris rather than on the plains, as they require semi-tropical conditions.

The tree is propagated by seeds, which take from 3 to 4 months to germinate and only a small percentage of which germinate. Pre-treatment of seeds, by soaking in hot water before sowing helps better and quicker germination. Root cuttings can also be used for propagation. The Mangalam Camp Estate in Wynad, belonging to Messrs. Techno-Chemical Industries Ltd., Calicut have successfully grown rooted shoots from old stumps, and have also attempted, with some success, grafting camphor on cinnamon seedlings as rootstock. Seedlings may be raised in baskets or bamboo pots and they are ready in about a year for planting out.

The commercial method of cultivation in Ceylon and other places is to plant out seedlings at distances of about 8 feet from each other and to successively clip the trees, commencing in about 4 years after planting, keeping the height of trees at about 5 to 6 feet. In well established plantations, trees may be clipped 3 or 5 times a year for distillation. For manufacture of camphor, the twigs and leaves obtained from the clippings are ground up, and the material is then distilled with steam for some hours. Solid camphor crystallizes on the walls of the still. Crude camphor oil settles on the surface of the water in the condenser and is skimmed off. A proper commercial method of cultivation of camphor is yet to be evolved on the Nilgiris. It is reported that on the Nilgiris, proper camphor extraction is not possible before the trees are 15 years old. A thorough investigation is however needed into all aspects of cultivation and camphor extraction on the Nilgiris.

The percentage of camphor and oil obtained from leaves and twigs of the trees in the Halacarai Estate in the Nilgiris is reported to be three. In the same estate, the yield of camphor and oil per year seems to have worked out to 60 lb. and 10 lb. respectively. This is rather low compared to an average total of camphor and oil amounting to 125 lb. in Ceylon. The plantations in this estate are however still young and the experience of camphor growing and extraction is also comparatively small.

In recent years, the camphor plant, *Ocimum kilimandscharicum*, has come into prominence as a possible source of commercial camphor in India. It has several advantages. It begins to yield camphor within 4 to 6 months of planting; it can be coppiced a number of times each year for a number of years; cattle, including sheep and goats, do not eat these plants; the leaves after being cut can be dried and stored even for a year, without loss of camphor, and thus the leaves can be conveniently transported to distant factories for distillation. The Forest Department on the Nilgiris considers this *Ocimum* as an ideal plant to grow on the hill slopes of the Nilgiris to control erosion, because of its good and efficient root system and perennial habit, and is growing this on the "Top Slope", for controlling soil erosion. Besides all this, the plant does not seem to be particular about the kind of soil, and seems suitable as a purely rainfed crop on the Nilgiris. Since this is of recent introduction, it will be sometime before its success on the Nilgiris can be properly evaluated. Experience by commercial firms such as Techno-Chemical Industries, Calicut, in their estates at Wynad, indicates that 1 per cent of camphor can be extracted from the leaves of this plant commercially, and about 40 lb. of camphor can be obtained per acre per year.

OIL-YIELDING GRASSES

Cymbopogon *spp.*

The genus *Cymbopogon* of the grass family is particularly rich in perfume plants. India has been for years having a good export trade in lemongrass oil obtained on distillation from the leaves of *Cymbopogon Citratus*, DC. It is a reddish yellow oil with a strong odour and taste of lemons. It is very much used in perfumery and toilet soaps, and is a source of ionone from which is made synthetic violet. It is also extensively used in medicine and as a flavouring substance. In recent years, U. S. A has been extracting Vitamin A from this oil. According to "The Hindu" of May 20, 1952, out of the 1,296,624 lb. of lemon grass oil imported by the U. S. A., 1,147,720 lb. or 90 per cent was obtained from India in 1946. But since that year, the American imports from India declined gradually, and it came to 41 per cent of the total imports in 1948. However, the production of Vitamin A from lemon grass oil in U. S. A. gave a stimulus to imports from India in 1950 and 1951, reaching 62 per cent of the American imports in these years. All this indicates the economic importance of grass oils to India.

According to forest authorities, lemon grass is found in large quantities in the forests of Nilgiris, but its industrial exploitation has been lagging behind.

Growing wild in the Nilgiris are the following other species of *Cymbopogon*:

(1) C *polyneuros*, Stapf., (Wild Rusa Oil or Geranium Grass), which is a coarse grass with a variegation of green and purplish colours, strongly scented, and found on higher elevations around Ootacamund, Pykara etc.

(2) C. *confectiflorus*, Stapf., (Wild Citronella Grass), found at lower levels of the Nilgiris.

(3) C. *lividus*, Stapf., (Purple grass), comparatively dwarfer than the other two and found in the open downs of the Nilgiris.

The potentialities of these grasses for useful oil are yet to be systematically worked out.

Besides this, regular and systematic work should be done on the Nilgiris to expand the growing and use of other oil-yielding cymbopogons such as the following :—

Cymbopogon Nardus, Rendle., which yields the oil of citronella, a pale yellow oil, much used for inexpensive soaps and perfumes and as insect repellent, also containing 80 to 90 per cent of geraniol, which makes the oil an important substitute for otto of roses.

C. Martinii, a source of palmarosa and ginger-grass oils, which contain large amounts of geraniol and are used to adulterate otto of roses.

GERANIUM

Pelargonium *spp.*

Geranium oil is distilled from the leaves of several species of *Pelargonium* among which are *P. capitatum*, *P. radula*, *P. graveolens*, *P. odoratissimum* and *P. roseum*. The main use of the geranium oil is to adulterate or substitute otto of roses in the manufacture of perfumes and soaps.

Geranium has been grown for a long time at the Government Botanic Gardens, Ootacamund, Sim's Park, Coonoor, and in recent years at the Pomological Station, Coonoor. In Yercaud, a hill station in Salem District, planters have been growing geranium and extracting geranium oil, but industrial use on the Nilgiris has not yet been evident. In Coonoor, on small field scale trials at the Pomological Station, pickings of 30,000 pounds of green leaf per acre at a time have been obtained, and the plants have been able to stand quite a few pickings in a year.

CLOVE

Eugenia caryophyllata, Thunb.

Oil of clove can be distilled from the cloves, the leaves and unripe fruits, and has various uses in medicines, perfumes, soaps, and in histological and microscopic work. Cloves on the Nilgiris grow well upto 3,000 feet elevation. The scope for utilization of clove trees for clove oil should be well investigated.

(Please see also articles "Spices and Condiments in the Nilgiris" and "Medicinal Plants in the Nilgiris").

CINNAMON

Cinnamomum Zeylanicum, Nees.

Cinnamon oil is distilled from the chips or waste bark obtained in the preparation of cinnamon quills, and has several medicinal uses and is used also in dentifrices and perfumes. Cinnamon thrives on the Nilgiris upto an elevation of 2500 feet. Preparation of cinnamon oil on the Nilgiris on a commercial scale is worth investigations. (Please see articles "Spices and Condiments in the Nilgiris" and "Medicinal Plants in the Nilgiris").

NUTMEG

Myristica fragrans, Houtt.

Oil of nutmeg is used in medicines, also in perfumes, soaps and dental pastes and for flavouring chewing gums, chewing tobacco etc. At Burliar Fruit Station, recently, the oil from the leaves has been under investigation as a herbicide. On the Nilgiris, the nutmeg trees thrive upto 2500 feet

elevation. (Please see articles "Spices and Condiments in the Nilgiris" and "Medicinal Plants in the Nilgiris".)

GAULTHERIA

Gaultheria fragrantissima, Wall.

Oil of wintergreen can be extracted from the leaves of the plant. The oil is a good antiseptic and is also used in the manufacture of insecticides and insect repellents. Salicylic acid used in the preparation of aspirin is also obtained from this oil.

Gaultheria is found wild on the Nilgiri plateau and is worthy of industrial exploitation.

* * * *

Besides these, trials in the Government Botanic Gardens and Parks of Nilgiris have demonstrated that the following essential oil plants can be *successfully grown on the Nilgiris, most of them on higher elevations.* Their industrial exploitation requires thorough investigations:

Calamus. *Acorus calamus,* Linn. (Sweet flag). Calamus oil is distilled from this plant, and is of use in perfumery and medicines.

Peppermint. *Mentha piperita,* Linn. Peppermint oil is distilled from the shoots and leaves and used in confectionery, pharmaceutical and perfumery trades. It is also used in the preparation of *Creme de mentha* and other liquors. It is also a source of *menthol,* a white crystalline substance valuable in the treatment of colds.

Rosemary. *Rosmarinus officinalis,* Linn. The rosemary oil is distilled from the fresh flowering tops of the rosemary plant. It has medicinal and perfumery uses, and is a component of *Eau de Cologne* and toilet soaps.

Thyme. *Thymus vulgaris,* Linn. Oil of thyme is distilled from this plant and is much used in perfumery. The oil is also a source of *thymol* used in mouthwashes, toothpastes and in medicines.

Apart from all this, attempts should also be made to try the following on the Nilgiris:

Bergamot, *Citrus Bergamia,* which yields a greenish oil from the rind of its fruits, extensively used in scenting toilet soaps.

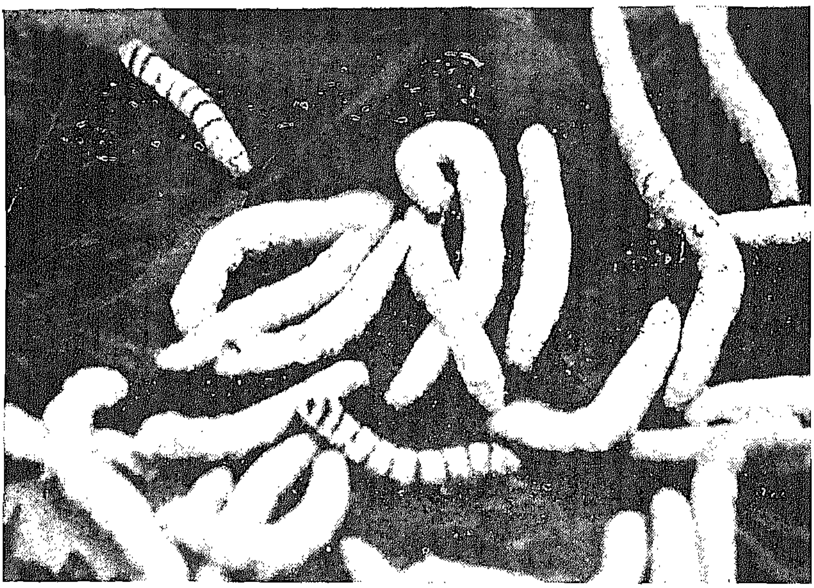
Cajeput, *Melaleuca Leucadendron* Var. *minor,* whose bark and leaves yield a valuable volatile oil, used in medicine as stimulant and tonic.

Champaca. *Michelia Champaca,* Linn. Champaca oil is obtained from this champak tree of India. Specimens of this tree are found thriving fairly well even at an elevation of nearly 7700 feet in the Government Botanic Gardens, Ootacamund. Some of the zones, with lower elevations might be very suitable for this tree. The oil is among the most famous perfumes of India.

Patchouli. *Pogostemon Patchouly,* Pellet. Patchouli oil is distilled from the fleshy leaves and young buds of this plant, is dark brown in colour and has a strong odour similar to that of sandalwood. It is used in perfumes, soaps, hair tonics and tobacco. It is said that cashmere shawls are always shipped in patchouli-scented containers and get a characteristic odour, associated in foreign markets with these shawls.

Carnation, lavender, chenopodium, lemon, sweet and bitter oranges, jonquil and narcissus are among other essential oil yielding plants which are bound to thrive in one zone or another of the Nilgiri plateau.

Mulberry leaves — Mildew resistant strain



Silk worms ripe for gut making.

16. MULBERRY ON THE NILGIRIS AS THE SOURCE OF NEW DEVELOPMENTS IN THE SILK INDUSTRY OF MADRAS

by A. T. JANAKIRAMAN, B. SC.
Sericultural Expert, Kollegal

"*Silk, the queen of textiles, has its uses both in war and peace, and it lends itself to the production of artistic designs which other textile fibres cannot*".

EARLY HISTORY AND DISTRIBUTION IN THE MADRAS STATE

It is clear from the geographical and historical evidences that the Sericultural Industry in Madras has had a parallel growth with that of Mysore. It is reported to have started in Kollegal Taluk of this State during the reign of Hyder Ali of Mysore, and in the whole of the Madras State, it is only in this taluk that sericulture has been carried on extensively as a cottage industry. In recent years, however, it has also spread to places like Hosur Taluk in the Salem District, Palmaner, Madanapalli and Kuppam Zamin in the Chittoor District, Talavadi area in the Gobichettipalayam Taluk of the Coimbatore District, and Coonoor Taluk of the Nilgiri District. Regular surveys have indicated a number of tracts in the Ceded and Northern Districts of this Province as also being suitable for the introduction of sericulture.

The extent under cultivation of mulberry, which is the food for the silkworms which produce silk, was 11,076 acres in 1920 – '21 and is now nearly 22,000 acres in the Madras State. The magnitude of the industry may be gauged from the fact that it supports 25 to 30 thousands of families in the State, and the annual production of silk is estimated at one and a half lakhs of pounds, now valued at about 75 lakhs of rupees. Sericulture is practised in most cases by small farmers as subsidiary to agriculture, and is the mainstay of these agriculturists.

INTRODUCTION OF SILK INDUSTRY INTO NILGIRIS

It will be of interest to note that between 1860 and 1890, there were mulberry gardens upto an extent of 50 acres in Katteri, Coonoor and Hullikal, owned by Major Michon, Captain Valluray, and Mr. Martally respectively. A fungus disease called mildew devastated the gardens and the venture suddenly came to an end. The industry was revived again in 1919, this time by the Government, by placing the head-quarters of the Sericultural Expert of the Madras Government at Coonoor and starting a small experimental farm there. After 1943, seeing the potentialities of development of foreign race rearings, the Farm at Coonoor came to be converted as a first class Hill Rearing Station, since the conditions were found approximating to those of foreign countries.

MULBERRY – THE FOOD OF SILK-WORMS

The mulberry leaf is the only known satisfactory food of the worms. Young tender mulberry leaves which have attained full size, are considered to be ideal for feeding silkworms. Culture of mulberry is therefore of prime importance to the industry, and the provision of mulberry leaves for silkworms represents the largest single item of expenditure in silk cocoon production, and the quality of mulberry leaf determines ultimately the quality of cocoons produced by the silkworms. The mulberry cultivated in the silk producing tracts in Madras is mainly the bush variety, and it is rainfed. It is propagated vegetatively and from seed, but the former method is the more widely practised. Methods of vegetative propagation are by grafting, layering or cutting, but the farmers follow the archaic method of propagation by cutting. But, however, in the recent years, the sericultural department has been endeavouring to popularise raising of seedling plantations and root grafts suitable for bush system of cultivation.

In the Nilgiris, there is a local variety, non-resistant to mildew, severe winter and heavy rain, and hence is not good. The mildew resistant varieties have been selected out of the foreign varieties and are being propagated on a large

scale by grafts. Two Japanese varieties are also being tried and are under experiment as to their suitability. The normal method of having bushes from cuttings have been replaced in the Nilgiris by having high bushes or dwarfs out of seedlings. Mulberry is also capable of being trained as a tree which requires less of attention. Mulberry is essentially a rainfed crop and the rainfall in the Nilgiris is more than sufficient for it. It grows on all kinds of soil and being deep rooted is suited admirably for slope lands. They are planted 5 ft. to 6 ft. apart and require little attention after the first two years. Manuring can be done with farmyard manure and green manures and to advantage with occasional liming.

Besides being the food of silkworms, mulberry also yields fruits which make excellant jam. The litter of worms and leaves are fed to cattle which relish them very much.

The mulberry is a perennial crop, and when proper attention is paid to maintenance and cultural operations, the life of a plantation could be extended upto twelve years.

LIFE HISTORY OF SILKWORMS

The silkworm *(Bombyx mori, L)* is a lepidopterous insect which undergoes complete metamorphosis from egg to adult. Eggs are laid in batches of 300 to 500 by female moths after copulation. In the case of eggs of polivoltine races of silkworms reared in Madras and Mysore, the incubation takes place at the ordinary temperature conditions. During a period of 9 to 10 days which constitutes the incubation period, the egg is hatched and the silkworm emerges as a small larva or caterpillar. These larvae are immediately collected from the egg sheets by sprinkling on them finely chopped tender mulberry leaf to which the newly hatched larvae or 'ants' adhere. This process of collecting hatched worms is technically termed as 'brushing'. Thereafter, the worms are carefully tended both day and night with regulated feeds, and the silkworms feed voraciously, periodically shedding their skin as they increase in size. The shedding of the skin is called 'moulting' or 'ecdysis'. The sikworms moult four times before they grow to

maturity. In five to eight days after the fourth moult, the caterpillars attain full growth, cease feeding and spin cocoons for pupation. The spinning of cocoon is known as 'mounting'. After ten to twelve days, the winged adult-moth emerges from the cocoon. Mating of moths and laying of eggs take place within a few hours.

Depending upon the number of generations produced in a year, the silkworms are classified into three 'voltine' types. Mono or uni-voltine strains usually produce one generation, bi-voltine strains two generations, and poli voltine strains several generations a year. The first two strains exclusively belong to temperate zones, while the last one is reared in tropical and sub-tropical zones. The most essential requirements of the silkworms-as indeed of all living creatures are food, air, suitable temperature and humidity. There are few natural enemies for these domesticated worms in the Nilgiris.

ROLE OF THE NILGIRIS IN THE PRESENT SCHEME OF SEED ORGANIZATION

The Indian sericulture particularly in Madras, Mysore and Bengal may have to depend on the uni - and bi - voltine silkworms for improving the industry. The indigenous race of silkworms generally reared in Madras, Mysore and Bengal is polivoltine in character. Though it possesses certain desirable characters such as a fine luster, resistance to diseases and drought, it fails to produce cocoons of good size and quality from the commercial point of view. In fact, the essence of the economics of cocoon production is that the commercial race of silkworm should have a shorter rearing period and thus lesser consumption of mulberry leaf, the cost of which at present forms the largest item (65%) of cost of production, and should produce greater output of cocoons and richer silk content. Unfortunately, the polivoltine races of silkworms in Madras and Mysore take a comparatively longer period of rearing and produce comparatively lesser yield of cocoons. This serious defect is made up now after careful experimentation and field work by the introduction of F_1 generation hybrids for

commercial rearings in the villages. The females of the indigenous races of silkworms are crossed with the males of uni- and bi-voltine races of silkworms obtained from China and Japan. Thus, in the present scheme of seed organization, the maintenance of exotic races for hybridisation is of paramount importance. Being the inhabitants of temperate climate, the exotic races of silkworms, through continued rearings in the plains, lose their vitality and become susceptible to diseases. Such degenerated races are unfiit for cross-breeding work. In order to maintain vitality of the foreign race, they have to be reared always under climatic conditions similar to their natural homes. The Coonoor taluk on the Nilgiris with an altitude of about 5,500 feet offers conditions of climate suitable for healthy rearing of these univoltine races. Thus, hill-rearing on the Nilgiris plays an important role in the scheme of hybridisation and seed organisation in the Madras State.

The Government Silk Farm at Coonoor is engaged in the rearing of stock races of silkworms suitable for cross-breeding work and in supplying high grade silkworm eggs of these races for multiplication in the Government Farms in the plains. The system of mulberry cultivation in Coonoor has been changed from the bush type to the middling type due to the susceptibility of bush plants to mildew disease which is common on the hills. The races of silkworms under rearing in the hill station of Coonoor have given highly encouraging results with decreased mortality, better development and growth of worms, and increased quality of cocoons. Having acquired increased resistance to diseases, the races of silkworm when multiplied in the plains for general cross-breeding purposes, were found to be absolutely free from diseases.

SILK GUT MANUFACTURE – A NEW INDUSTRY ON THE NILGIRIS

In recent years, the preparation of silkworm ligaturo guts for surgical purposes has assumed greater importance. The chance discovery of the presence of glands in silkworms about a century ago, capable of stretching into long threads by a Murcian rag picker led to the establishment of the gut industry in Spain. Annually ,about 90 lakhs of strands

of guts were produced which formed the material for ilgature purposes in surgery and for fishing.

Gut Industry in Madras is of recent origin. Requirements of Indian hospitals were imported from foreign countries till the commencement of world war II, when we were thrown on our own resources. Madras took the lead in producing about 75 lakhs of guts in Kollegal, which were consumed by the Medical Stores Department. Unfortunately after the cessation of hostilities, import of guts was resumed much to the detriment of local industry. This gave an impetus however to improve the quality of guts and place it on a par with that of imported ones. The production of quality guts presupposed good development of worms. Since the foreign races of worms were found to show good development on the hills, the Gut Manufacturing Section was shifted from Kollegal to Coonoor in 1948, and a scheme for the expansion of gut industry has been recently sanctioned with the altimate aim of producing 10 lakhs of guts a year for meeting the requirements of Government hospitals.

For the preparation of suture guts, robust ripe mulberry silkworms are selected and soaked in a dilute solution of acetic or citric acid for a period of three to four hours. The worm is taken out from the acid bath and the head is cut. Then, the abdomen of the worm is gently pressed by the thumb and the forefinger, when the two glands inside the worm come out. With uniform pull and deftness of fingers, the silk glands are stretched to a length of 12 to 16 inches. Later, the raw guts are bleached and polished. The Medical Department requires guts of certain standard thickness and length. Generally guts of 12 in. long and 0·012 to 0·013 in. diameter are preferred. Substandard guts are made into plaited or knotted gut-casts and for mounting hooks which are favoured by the anglers. Waste guts are used as bristles in brush manufacture. This new line of development of the silk industry in the Hills has a hopeful future.

THE FUTURE OF THE INDUSTRY ON THE NILGIRIS

The cultivation of mulberry and the rearing of silkworms for the production of commercial cocoons could be

profitably introduced in the coffee and tea estates on the Nilgiris for the benefit of the estate labour. It is seen that the estate workers are not generally busy in the coffee or tea gardens throughout the year, and the silk industry could be practised by them during their off season so that the income of the family could be augmented. Mulberry trees could be raised along the hedges and also in rows about 10 to 12 feet apart in the tea and coffee gardens just like the silver-oaks planted for shade purposes. Necessary assistance such as free supply of mulberry plants and technical advice in planting of mulberry and rearing of silkworms would be given by Sericultural Section of the Madras Industries Department, on the Nilgiris. The silk gut industry bids fair to add itself to the number of important agro-industries of the Nilgiris. The temperature and humidity conditions being ideal both for seed cocoons and extraction of guts, it requires only human endeavour to expand the Silk and Gut Industry on the Nilgiris.

CONCLUSION

The Nilgiris is acclaimed to be the "Queen of Hills" affording abiding shelter to men who need recuperation of their health and to a variety of plants of economic value-both horticultural and commercial. Mulberry also aligns itself among the economic plants in the sanctuary of The Nilgiris. Perhaps, it is in the fitness of things that the "Queen of Hills" should offer scope for the cultivation of mulberry leaf which is the staple food of silkworm–producer of the "Queen of Textiles".

17. FOOD PLANTS IN THE NILGIRIS

The Government statistics for 1949–50, available at the time of writing show that the Nilgiri District in that year had the following acreages under food plants:

Potato	16998	acres.
Rice	7969	,,
Samai	4564	,,
Ragi	4183	,,
Wheat	883	,,
Tapioca	388	,,
Tenai	295	,,
Barley	192	,,
Sweet potato	94	,,
Cholam (Sorghum)	38	,,
Maize (Corn)	12	,,
Total	35616	,,

Thus, in a district which has been noted mostly for plantation and horticultural crops, food plants also occupy a sizeable area of nearly 36000 acres but do not contribute however to the self-sufficiency of the district, resulting in the necessity for imports from other districts to meet the deficit in staple foods.

Of all these food crops, potato occupies the largest area, normally extending to 20,000 acres and this is a case of a horticultural plant, contributing directly to food, rather than to food adjuncts such as other vegetables. Potato is dealt with in detail in a separate article "Potato on the Nilgiris" and will not be dealt with in this article. Brief notes are given below on other food plants.

1. **Rice.** *Oryza sativa*, L. Graminae.

Rice is grown only in the lower elevations of the Nilgiris, about 3500 feet and below. Gudalur taluk and the Wynad side contribute most of the area in rice. The methods of cultivation of rice here, while following the general principles of growing rice, still have scope for improvements and the Department of Agriculture has concentrated in recent years in

increasing production in the rice tract of the Nilgiris by introducing better strains of seed paddy and better scientific methods.

2. **Samai.** *Panicum miliare.* Graminae.

Samai and ragi are the two important staple food crops of the agricultural communities on the Nilgiris and as is evident from the extent under these crops furnished above, they hold fairly equal areas, being 4564 and 4183 acres respectively. Three varieties of samai are recognized viz.

(1) *Aruvai samai*, early variety of 4½ months duration. This is not very popular. The straw is relatively more fibrous and hence more unsuitable to cattle. The indigenous population consider the grain of this variety as comparatively more heaty to the system.

(2) *Karai samai*, (meaning black variety), of medium duration of about 5 months, with fair quality of grain and straw.

(3) *Aru samai*, a late variety of 5½ to 6 months' duration with brown coloured grain. It is best of the three for both food and fodder.

In the eastern zones with fear of heavy north east monsoons, the short duration variety is preferred. In the western zones. with no such fear, the long duration is preferred. April to August is the main season for samai. In lands where a second crop is possible between September and January, after a crop of potatoes, ragi is preferred, as it responds very well to the residual effects of manuring of the previous crop of potatoes.

In normal conditions, the land is prepared in January–February and the seeds are sown in the end of March, anticipating the April showers. If it is not sown thus, the farmers wait for very good rains before sowing. If there are no reasonable rains till the end of April, no sowing is done. 50 lb. seed-rate per acre is used and a yield varying from 600 to 1000 lb. is obtained.

3. **Ragi.** *Eleusine coracana*, (L.) Gaertn. Graminæ.

The importance of ragi as a staple crop of the agriculturists in the Nilgiris has already been stated above. Uptodate the local strains of ragi, grown by the farmers for a long time, hold the field. Strains of ragi evolved by the Government Department of Agriculture for the plains have not done very well on the hills and take a longer duration than in Coimbatore. For instance, Co. 1 evolved at Coimbatore Millet Station is of about 3½–4 months' duration in Coimbatore but takes nearly 5½ months on the Nilgiri hills. Beyond Ootacamund, on the Nanjanad side, the soils are more acidic and unsuitable for ragi.

4. **Wheat.** *Triticum vulgare*, Host. Graminæ.

Nilgiri district has been one of the very few zones in South India where wheat has been cultivated for a long time. While the Coimbatore District used to grow some wheat in the cold weather, other more remunerative crops have replaced it entirely. The normal area of wheat on the Nilgiris has been around 1000 acres. But its cultivation received somewhat a set back during the last decade, due to a ban imposed on the cultivation of wheat on the Nilgiris, on the plea that the spores of wheat rust wafted all

the way into Northern India to spread infection into Northern Indian wheat. It is learnt that the belief is not held so strongly now. At any rate, cultivation of wheat has been continued.

The wheat chiefly grown has been a bearded kind, in which the husk adheres very closely and it can only be removed by pounding. The Badaga agriculturists of the Nilgiris consider this characteristic of the variety an asset, as it resists weevil attack. There is also the "naked wheat" as the Badaga call it, in which the husk comes off easily. This is a European variety said to have been introduced by Mr. J. Sullivan, but the quality of this eventually deterioratad due to mixing with other varieties.

Originally, wheat was grown by the Badagas as a measure of home economy, to meet their own family needs particularly for their midday lunch and were grown along with vegetables, amarantus etc. But in recent years, they have been marketing wheat for outside consumers. Wheat is grown in small fertile areas in villages in two distinct seasons on the Nilgiris, (1) April–May to August–September and (2) September to January. For Coonoor area, April to September is more favourable and for Ootacamund–Ketti area, September to January is more favourable, as the north east monsoon does not affect the flowering in this area. In the latter zone, wheat follows the harvest of potato in July–August and benefits by the residual effect of the heavy manuring of potatoes. The average seed rate is 60 lb per acre and the wheat crop is of 4 to 4½ months duration. It yields on the average about 600 lb. per acre. However, the yields have gone up in some years to 1500 lb. per acre.

The Pusa "naked" types of wheat grown in the villages are subject to rust attack. Very recently, rust resistant types of wheat have been imported from Australia, such as *Celebration, Charter, Gebo, and Kendee.* The first three of these types look alike in grain, size and colour, but Kendee has brownish earhead. Some of these Australian strains have yielded upto 2000 lb. grain per acre.

5. **Tapioca.** *Manihot utilissima,* Pohl. Euphorbiaceæ.

The acreage under tapioca is around 400 acres in the Nilgiri District normally, and is mostly grown in the lower elevations of the Gudalur area, as a food crop. The methods of propagation, planting and cultivation are similar to those on the plains.

6. **Tenai.** *Setaria italica,* (L) Beauv. Graminæ.

With its acreage around 300 acres, tenai is one of the minor millets of the Nilgiris and is grown in the eastern slopes of Ootacamund taluk and lower elevations.

7. **Barley.** *Hordeum sativum,* Pers. Graminae.

Barley assumed importance in the Nilgiris for many years for brewing beer. It occupied about 1,000 acres at its best but gradually declined, and with the introduction of prohibition has come down to around 200 acres. Several varieties have been known in barley on the Nilgiris. The six-rowed naked kind is called by the Badagas as "*Akki ganji*". Another six-rowed glumed variety is known as "*Beer ganji*" or "*Dorai Ganji*", from which beer and malt used to be made but from which it is difficult to make flour. The latter variety is supposed to have been introduced originally by Mr. Sullivan. There is also an indigenous variety called the *Badaga ganji*.

Barley is now grown on the Nilgiris in small pieces of land round about villages alongside of wheat, and the grain and flour are prepared and eaten in several ways by the Badaga and other agricultural communities.

Sweet potato, cholam and corn (maize) are grown in much smaller areas in the lower elevations and their cultivation methods do not differ from those in the plains.

There are however other food plants which have not come into the regular statistics collected by Government but which do play some part in the rural and family economy of the agricultural communities in the Nilgiris, and there are still others like the buckwheat whose importance as a food plant in these hills is being more and more realised. These are dealt with below :—

Badaga keerai. *Amarantus paniculatus, L.* Amarantaceæ.

This amarantus species has for a very long time been grown on the Nilgiris and is grown in almost every Badaga holding. There are two varieties, (1) with purple stem producing purple seed and (2) with green stem producing white seed. The seeds of this species are puffed, and the puffed grains, like puffed rice, are used in various ways by the Badaga community, sweetened, mixed with butter milk or converted into flour and used. While this does not find a place in the markets for sale, it is widely used at home and also fed to the labourers who work on the fields in the Badagas' holdings. Besides the use of the grains as food, tender plants are used as vegetables and mature leaves boiled with potatoes and eaten. It has been in fact a principal "green" vegetable for the Badaga community as long ago as they can remember. The crop is of four months' duration.

Korali. *Hordeum spp.* Graminæ.

Originally this seems to have been the only staple millet for the agricultural colonists, the Badagas. But in the competition with other food grains, it has not been able to survive as an important grain crop. However there has been a natural mixing through the years with samai, *Panicum miliare* on the Nilgiris, and it is estimated that the samai seeds usually used for sowing on these hills contain upto 1 per cent of korali. Korali straw is considered among the best straws for cattle feed.

Buckwheat. *Fagopyrum sagittatum,* Gilib. Polygonaceæ.

This is said to be a native of Central Asia and growing wild in Manchuria and Siberia. It is recorded also as constituting one of the chief foods of the Russian peasants. Large crops are known to be raised in France, Germany and the United States of America.

The buckwheat plant is a small branching annual, with smooth and succulent stems and alternate hastate leaves, with inflorescence in

axillary and terminal cymes with densety clustered, small white or pinkish flowers and the fruit is a three cornered achene, containing triangular shaped seed.

It is surmised as having been introduced into Nilgiris by French missionaries in Kotti; and by all observations on the higher elevations on the Nilgiris, and trials at the Agricultural Research Station, Nanjanad, it is one of the most suitable food-crops for the Nilgiris and has many advantages over the other food crops such as ragi and samai. It is a quick grower maturing in about 3½ *months*; *it comes up with comparatively little* care; it covers the ground so rapidly that it is useful against soil erosion on the hill slopes; it is also a good green manure and catch crop; and it is hardy against both frost and drought. Moreover, the food value of the buckwheat grains is very high and the Nilgiri samples analysed by the Nutrition Research Laboratories at Coonoor showed 12·3 per cent of high quality protein, with three principal B vitamins viz. thiamine, riboflavin and nicotinic acid being 300 micrograms, 341 micograms, and 0·81 milligram per 1000 grams respectively.

On the Nilgiris, buckwheat can easily be grown after potatoes, in the place of wheat, barley or ragi and wherever the soil is comparatively poor and the land far off from towns. The Kurumba tribes have taken to agriculture rather recently in the Melur slopes, and the Agricultural Department introduced buckwheat into their rotation, and they have come to like the buckwheat very much from all accounts. The Badagas have been also growing buckwheat, and have been converting it into flour and making several preparations with it, as salted balls or as fried *vadais* etc.

Buckwheat requires a seedrate of 40 to 50 lb. per acre and an average yield of 300 to 400 lb. per acre can be obtained. Yields upto 600 lb. have also been obtained. There are two varieties of buckwheat on the Nilgiris, one with husk and the other naked

There are several ways in which buckwheat is useful. The seeds or "groats" as they are called are hulled and ground, and the resulting starchy flour can be used for soups. porridge and for pancakes (*Dosais* in tamil). The whole grains and flour are very good feed for livestock and poultry. The straw is also very good for cattle feed and bedding. The flowers are a good source of honey.

Besides all this, some years ago, scientists of the Eastern U. S. D. A. Regional Laboratory in Philadelphia, U.S.A. discovered that buckwheat is the most promising source of *rutin*, a flavonal glucoside, very effective in the treatment of increased capillary fragility associated with hypertension in man. These scientists reported 8·65 per cent of rutin in buckwheat plant exclusive of roots.*

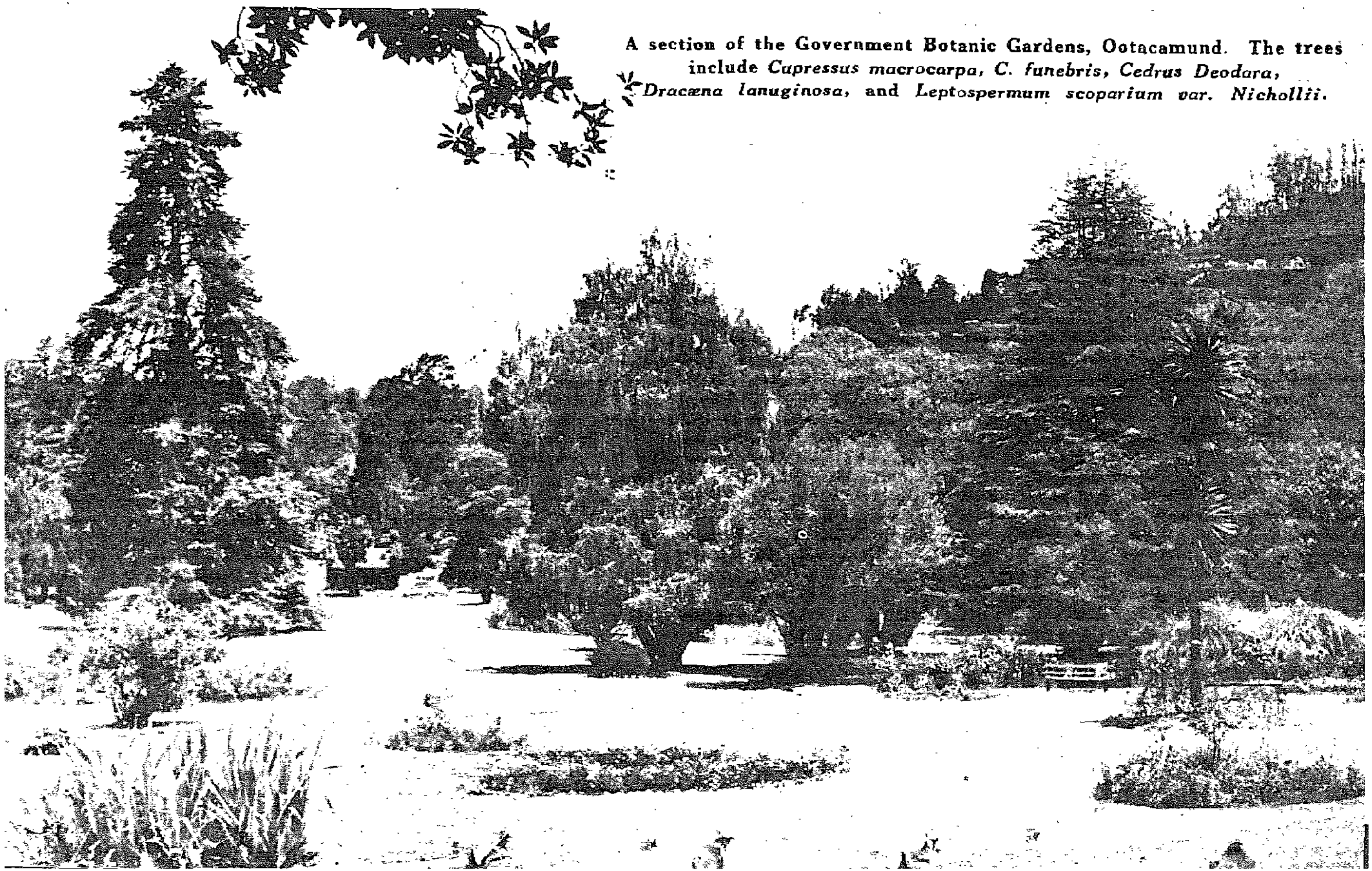
Oats. *Avena sativa*, L. Graminae.

Reports of trials of oats at the Agricultural Research Station, Nanjanad indicate that oats can be grown successfully on the higher elevations of Nilgiris, as evidenced by yields of 1,250 lb. grain and 12,800 lb. straw per acre in 1935—'36. Oats can be grown with profit after early potatoes. The Patna varieties of oats are supposed to be good for hay and the Australian or New zealand varieties for grain. It has not however assumed much importance on the Nilgiris.

* Couch J. F., Naghstei J., and Krauson C. J. Buckwheat, Rutin and Hypertension. *Science*. 103: 197. 1946.

Lentil. *Lens esculanta,* Moench. Leguminosae.

Lentil is considered as among the most ancient and most nutritious of food crops. The lentil plant is an annual which is slender, tufted and much branched, with short and broad pods, with small lens shaped seeds. The seeds, when used in soups etc. are more easily digested than meat and are a good substitute for meat. Lentil has found its way into the Nilgiris among other introductions, and is grown and used as a pulse in the place of dholl by the Badagas and other agricultural communities of the Nilgiris.



A section of the Government Botanic Gardens, Ootacamund. The trees include *Cupressus macrocarpa, C. funebris, Cedrus Deodara, Dracæna lanuginosa,* and *Leptospermum scoparium var. Nichollii.*

18. USEFUL TREES FOR THE NILGIRIS

For more than a century, the staff of the Government Botanic Gardens, Ootacamund, have been doing systematic work of introduction of trees of all kinds from various parts of the world, for trial and establishment of trees suitable to the Nilgiris, particularly for the higher elevations of 5000 feet and more. Innumerable species of trees have been established as a result of this work in the Government Botanic Gardens, Ootacamund and Sim's Park Coonoor, and these two gardens are together the international home of fairly representative species of trees from practically all over the globe. The authors have had the privelege of making observations of all the established species in these gardens, and consider the 159 species described below as among those worthy of attention as useful trees for the Nilgiris in one way or another. Limitations of space do not permit more than very brief points being mentioned as characteristics and uses of these trees. Several of the species mentioned herein have already come to occupy an important place in the horticulture of Nilgiris. Over 5000 feet elevation, the cypresses, particularly *Cupressus macrocorpa* (common cypress), *C. torulosa* (Bhutan cypress), and *C. funebris*, (weeping cypress), are seen well distributed. *C. torulosa* with its beautiful shape and ornamental appearance is seen to decorate avenues with grandeur and stand as stately sentinels on either side of the railway lines of the Nilgiris. In groups, on the fringes of lakes such as the Ootacamund lake, and on slopes here and there, this cypress enhances the attraction of the travellers' resorts of the Nilgiris. Some of the finest specimens of *C. torulosa* are seen in Government Botanic Gardens, Ootacamund. *Cupressus macrocarpa* at its suitable elevations is used almost everywhere as a graceful, but impenetrable hedge, and in some cases forms a fort-like unassailable wall of huge proportions, as in the compounds of some of the largest Palace Gardens of Fernhill such as the Mysore Palace. Moreover, one of the best materials for topiary work on the higher elevations of Nilgiris is *C. marocarpa.* It is also a good

fuel. *Cupressus funebris*, with its weeping habit, and a fine size and shape dots also the landscape of the towns of Nilgiris. Jacaranda particularly in the Coonoor area is fairly extensively planted and needs to be further planted and when in flower in the beginning of the summer on the hills, it is one of the most glorious sights. So are group and solitary specimens of *Prunus puddum* (Himalayan cherry) looking aflame with their rose red fascicles, covering completely almost every part of its branches, without the leaves to mar their continuity at the flowering stage. The Grevilleas and the Acacias are others which are widely distributed on the ups and downs of the higher range of the Nilgiri plateau, and add to the glamour of the hill landscape. In the neighbourhoods of Coonoor and Ootacamund and in the gardens and parks, the tree fern *Alsophila australis*, a tree of geologic ages stands in groups here and there by the side of brooks and elsewhere, with its magnificent crest of fronds. All these and others make Nilgiris worthy of the name "the land of loveliness".

The Government Botanic Gardens, Ootacamund and its sister institution, Sim's Park, Coonoor, besides introducing numerous exotic species of trees, have grown also indigenous trees of the Nilgiris and demonstrated the ornamental and economic value of some of these species such as *Michelia nilagirica*, *Elæocarpus oblongus*, *Rhododendron arboreum*, *Engenia arnottiana*, *Meliosma arnottiana*, *M. Wightii*, etc. These are also included in the species dealt with in this article besides the Acacias, the Quercuses, the Araucarias, the Magnolias, the Pines, the Padocarpuses, the Acers, the Albizzias, the Callistemons, the Eugenias, the Prunus, and the Palms, as also certain rare botanical species such as *Ginkgo biloba* and several trees and families of deep interest to botanists and horticulturists. The estimated sizes of trees and description given relate to the specimens in Government Botanic Gardens, Ootacamund, and Sim's Park, Coonoor.

No visiter to Nilgiris can miss the *Eucalyptus* (blue gum) plantations, with their trees straight, tall and shooting to the skies. 35 species of Eucalyptus on the Nilgiris have been separately dealt with in an article on "Eucalyptus

on the Nilgiris" and hence *Eucalyptus* species are not treated here.

Providence has furnished the Nilgiris with fertile soil, a suitable climate, a fair share of rains, all prerequisites for vigorous growth of sub-tropical and temperate trees, evergreen and deciduous. And a century of trials leads us to indicate the species of trees suitable for the Nilgiris, for the higher elevations, where human habitation is more intensive. Trees perform to society multifarious duties, affording beauty and shelter, protection against winds, avenues for the roads, raw-materials for afforestation, and various agricultural and economic uses. The Nilgiris in particular is a plantation district of coffee and tea, and trees serve a number of special functions in the tea and coffee plantations. Above all, for the last decade and more, vandalism and ruthless greed have been rampant on the Nilgiris, cutting and felling down trees on a mass scale, leaving the slopes of the Nilgiris bare and helpless against erosion, spoiling the beauty of this Queen of Hills, leading fast to barrenness of agriculture, and holding in jeopardy the hydro-electric projects down below which depend on the rivers from these hills, which carry at the present time silt of dangerous proportions.

For all these reasons, the emphasis on trees useful for Nilgiris in this article is appropriate and it is hoped that a number of species which are mentioned here as worth while but planting of which has not come into vogue due to lack of knowledge of these trees, will receive an impetus from the public in general, and horticulturists and planters in particular, so that the landscape of the Nilgiris receives a wider variation of vegetation than exists at present and so that the useful purposes of trees on the Nilgiris mentioned at length above are fulfilled.

In may be mentioned here that this is the first time that information on 159 species of trees useful for Nilgiris has been brought together.

1. **Acacia dealbata.** Silver Wattle. *Leguminosæ.* Australia.

A handsome quick growing tree common at the higher elevations of the Nilgiris, growing to a height of about 20 feet. The very finely divided leaves, and profuse heads of yellow flowers are quite ornamental.

Flowering during March–April and September–October. The bark contains a good percentage of tannin, and is a good wattle tree.

The Acacias are propagated from seeds sown as soon as ripe. If old seeds are to be used, they are soaked in hot water for 24 hours. Also propagated from cuttings of half ripened wood with heel inserted as soon as made in equal parts of peat and sand.

Suitable for elevations between 6000 and 7000 feet.

2. **Acacia decurrens,** Willd. Green Wattle. Tamil: "Seekkai". *Leguminosæ.* Australia.

This tree is of even quicker growth than A. dealbata. Extensively grown in plantations for extraction of the bark which contains tannin used in the tanning industry. Attains a height of about 20 feet. Very finely divided leaves. Flowers seen during March–April. Propagated by seeds. Suitable for elevations about 6000 feet.

3. **Acacia elata,** Cunn. *Leguminosæ.* Australia.

A handsome tree, 50-60 feet high, with dark green foliage. Young shoots clothed with yellow pubescence. Suitable for elevations between 6000 and 7000 feet. Flowers creamy yellow, borne during March–April. Propagated by seeds.

Ornamental with its dark, green foliage. Timber also said to be valuable.

4. **Acacia melanoxylon,** R. Br. Blackwood Acacia. *Layuminosæ.* Australia.

A tall growing ornamental evergreen tree reaching a height of 70 feet and a spread of 35 feet Has pyramidal form and dense foliage with characteristic phyllodes (vertically dilated leaf stalks). Comes up well at Ootacamund and Coonoor. Has wide adaptability. One of the impressive Acacias. Propagated by seeds.

Useful for wind belts. Wood hard and durable. The hard wood, dark brown, beautifully mottled, shining and evengrained, is useful for cabinet work, agricultural implements, and takes fine polish.

5. **Acacia parvissima,** F. v. M. *Leguminosæ.* Australia.

The tree grows to a height of about 56 feet, spreads to about 50 feet and the diameter of trunk varies from 2½ to 3 feet. Branchlets decurrent, pendulous and heavy with sessile and peculiarly lobed short leaves. Shape of the tree is semi globose. This is one of the showy species among the Acacias. Flowers during March–May. The small, yellow scented flowers in racemes are attractive during the season. Suitable for elevations as those of Ooty and Coonoor (5600 to 7700 ft.).

A very, graceful, showy tree because of its pendulous branches, showy yellow flowers, useful for ornamental purposes.

6. **Acer Caudatum.** *Aceraceae.* Himalayas.

An attractive medium sized tree of the deciduous type, bearing flowers in axillary and terminal corymbs. Fruits with bright red carpels and winged-seeds, are clustered in long pendulous heads.

Propagated from seeds and with difficulty from cuttings of soft or ripe wood. Tree of ornamental value.

7. **Acer Laevigatum**. *Aceraceæ*. Himalayas.

This tree is similar to *A. Caudatum*. Height 30 feet and spread 20 feet. Leaves linear, green, with distinct veins, turn red just before falling. Flowers white in axillary and terminal corymbs. Seeds winged and borne in clusters. Propagated by seeds.

8. **Acer Negundo,** Linn. Ash Leaved Maple. Box Elder. *Aceraceæ*. North America.

A species successfully grown at Ootacamund. More deciduous than any of the other Acers. This middle sized tree with its yellowish green foliage especially in the tender stage and its small yellowish green flowers hanging in hairy clusters just before the season starts justifies its inclusion as a decorative tree. A rapid growing tree of spreading habit, suitable for wet soils. Good for shelter belts. A variety of this species, *var. elegantissima aurea,* is of very fine foliage, nicely variegated, pale yellow and green, and a very beautiful tree. Leaves fall off in November and new leaves appear in January.

A tree of ornamental importance.

9. **Acer oblongum,** Wall. Maple. *Acereceæ*. Nepal and China.

Medium sized shade-giving tree with spreading branches and with attractive flowers in terminal corymbs and very showy. Grows upto a height of 50 feet to 60 feet with a spread of 50 feet and with trunk diameter of 3 feet. The tree is semi or three-fourth globe shaped Not markedly deciduous and never conspicuously leafless in any part of the year. The young shoots are of a beautiful brown colour. The flowers are pentamerous, calyx and petals having the same greenish white colour. Flowering commences in February. The fruit has a long reticulate wing. Dormancy between November and January. Suitable for growing at elevations as those of Ootacamund and Coonoor (5600 to 7700 feet).

An ornamental, shade giving tree.

10. **Aesculus panduana.** Horse Chestnut. *Hippocastanaceæ*. Sikkim (India),

A medium sized tree, considered hardy at Coonoor and Ootacamund. A beautiful flowering tree with a dense round head of foliage with panicles of showy white flowers in cymose clusters on long peduncles. Easily attracts the attention of visitors during the flowering period, September to December. Digitate big sized leaves are deciduous. The tree has grown at Ootacamund to a height of about 25 feet with an equal spread.

Propagated by seeds, or layering. A beautiful tree when in flowers.

11. **Agathis robusta,** Hook. *Pinaceæ*. Queensland.

A tall tree with almost cylindrical straight trunk with thick cylindrical branches, starting horizontal and then growing upwards. Height 60 to 70 feet, spread 25 feet and trunk thickness 3 feet. Bark smooth, bluish white. Cones appear during September–October. Propagated by seeds

and cuttings. Timber valued very much for building purposes. Grows well at altitudes between 4000 and 7000 feet.

A good ornamental tree.

12. **Ailanthus grandis.** *Simarubaceæ.* Tree of Heaven.

A large and tall growing deciduous tree. Leaves change to a rich yellow colour previous to shedding. The flowers are in axillary panicles. Adapted for growing at elevations of about 6000 feet.

Propagated from seeds and also from suckers, or root cuttings.

An ornamental tree. Deserves inclusion among hardy rapid growing trees.

13. **Albizzia Julibrissin,** Durazz. Nemu. Silk tree. *Leguminosæ.* Asia and Africa.

A medium sized Acacia-like hardy tree with low spreading, flat topped head and finely divided dark-green leaves. Blooms in summer, bearing large clusters of pink flowers. Suitable for Ootacamund and Coonoor, (5600 to 7700 feet).

14. **Albizzia lophantha,** Beth. Plume Acacia. *Leguminosæ.* New Holland.

A quick growing tree with showy pink flowers. Suitable for elevations from 6000 to 7000 feet. A tree with spreading branches with finely divided leaves.

Ornamental because of its showy pink flowers. Timber used as planks for doors, windows etc.

15. **Albizzia stipulata,** Boiss. Saw tree. Tamil: Pilivagu, Kenarese: Betta Bagai. *Leguminosæ.* Himalayas.

A large fast growing tree having a broad crown giving a good shade. The tree grows to a height of about 50 feet with equal spread, loose branching. Young shoots tomentose with large persistent stipules. When flowering, the branches are completely clothed with flowers. A graceful tree with feathery foliage. Its yellow flowers in terminal compound racemes are seen from about April to June. Propagated easily by seeds.

A stately tree giving shade over a large area.

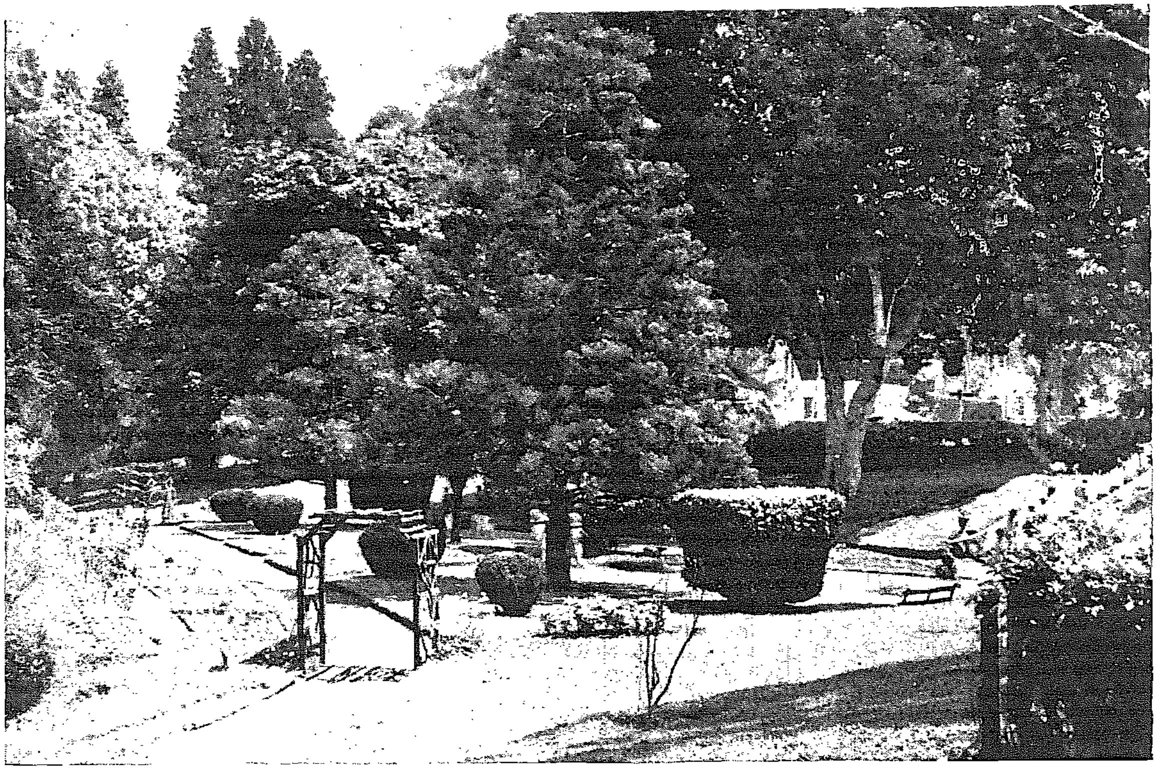
16. **Alnus nepalensis.** Alder. *Betulaceæ.* Himayalas.

A quick growing tree of about 90 feet in height with a spread of 50 feet. The bark is smooth grey in colour, This is said to be a tree that can grow under wet situations where other trees are likely to fail. Leaves big sized and ovate. The pendulous catkins of flowers are attractive. The seed is a nut with a wing.

Propagated from seeds, rarely from cuttings.

17. **Alsophila australis,** R. Br. Tree Fern. Cyatheaceæ.

A tree fern growing almost in a wild state in Nilgiris, with a magnificent crest of fronds and measuring upto abont 16 feet in height. Seldom



A section of Sim's Park, Coonoor. The trees include *Auracaria bidwillii*, *Cryptomeria japonica*, *Camellia japonica*, *Cupressus torulosa* and *Elæocarpus oblongus*.

seen to such perfection elsewhere, as in the Nilgiris. Fares better at Coonoor than at Ootacamund.

Propagated by division or layering. When bulblets are formed on the fronds, these can be grown under glass.

A tree of geologic ages. Said to be becoming extinct from the plant kingdom. A very good ornamental tree, attractive in groupings and for landscape effets.

18, **Angophora subvolutina.** Gum Myrtle. *Myrtaceae.* Australia.

This tree is closely allied to the Eucalyptus. Very tall growing in habit, trunk straight, 100 feet tall, spreading to about 70 feet with 4½ feet diameter at the base of stem. Tree is broadly conical. The bark rough, ash coloured and peeling off in bits. White bunches of corymbose flowers are produced in April–May. Exudation of red gum is very characteristic.

An ornamental tree, the timber of which is valued very much for building purposes.

19. **Araucaria Bidwilli,** Hook. Queensland Monkey Puzzle. Bay Pine. *Pinaceæ.* Australia.

This huge evergreen conifer with stout trunk is striking with its dark-green, glistening, rigid and prickly foliage, slightly twisted and arranged spirally over the long rachis in clusters at the ends of the horizontally spreading branches. This species comes up well at elevations between 3,000 feet and 7,000 feet. The tree is 100 feet tall, 90 feet broad, broadly conical. Cones of the size of unhusked coconuts are produced and are reported to be edible. This conifer is reported to be capable of living for 400 years. Propagated by seeds, also by cuttings with proper technique. Seeds available from Coonoor in January–February.

A very beautiful, stately ornamental tree. Can also be grown as pot specimens, showy, with pineapple like cones.

20. **Araucaria Cookii,** R. Br. Cook's Araucaria. *Pinaceæ.* New Caledonia.

This is similar in growth to *A. excelsa* and is only next to it in beauty, though lacking its almost perfect symmetry, This has come up equally well both at Ootacamund and Coonoor, attaining a height of about 80 feet with a spread of about 16 feet and the trunk diameter of 1½ feet. The leaves are spirally crowded, bright green, broad and terminating in a short point and the crown is narrowly conical. Stately and beautiful. Branchlets turn upwards in boatlike form.

A tree with a beautiful coniferous shape. Best suited as solitary specimens in wide lawns.

Propagated by layers as well as seeds.

21. **Araucaria Cunninghami,** Sweet. Moreton Bay Pine. *Pinaceae.* Australia

Another remarkable species of Australia, attaining a good height and girth. It has a clear stem for a considerable height from the base. The shape is pyramidal, the branches spreading horizontally in whorls, the foliage softer and more like that of cypress. Propagation by seeds. Propagation by cuttings is possible, though the plants raised by cuttings are reported to lack the grace and symmetry of the seedling trees. Plants less formal and symmetrical than *A. excelsa.*

Ornamental tree because of its shape and foliage. Yields valuable timber and resin.

22. **Araucaria excelsa,** R. Br. Norfolk Island Pine. *Pinaceæ*. Norfolk Island.

It is considered that this tree is unrivalled in beauty by any other plant, with its majestic stand over a lawn, with its grand array of horizontally placed leaves leaving the trunk altogether symmetrically at well placed points and growing high to a tapering structure of exquisite beauty. At Coonoor it reaches a height of 60 feet and spreads to 24 feet. The trunk measures about a foot in diameter.

This species is generally raised from seeds. The wood is considered good for indoor work. Used also as small pot specimens.

23. **Arbutus rollissoni.** *Ericaceæ*.

An ever-green tree growing to a height of 25 feet and a spread of 30 feet. Leaves shiny green, glossy. Bell shaped flowers borne in clusters between September and February. Not very impressive at Coonoor.

24. **Arbutus Unedo,** Linn. Strawberry tree. *Ericaceæ*.

A beautiful evergreen tree with dark glossy leaves and smooth bark of reddish shade, bearing clusters of white bell shaped flowers from September to February. Very attractive when laden with its scarlet strawberry-like fruits. Grows to a height of 15–30 feet. Thrives well in sandy soils. Propagation is by seeds. Budding and grafting can also be done in the case of superior varieties, on seedling stocks.

Very attractive with its bell shaped white flowers. Roots and leaves are astringent.

25. **Bæckia virgata,** Anders. Australian May (Ooty name). Ti Tree of Australia. *Myrtaceæ*.

A small tree growing very wild on the Nilgiris, with a height of 25 feet and an average spread of about 25 feet. The bark is dark brown, peels off in long thin strands. Leaves very small. Flowers white, borne in clusters between April and June.

Valued as an ornamental tree, with its twisted like stem.

26. **Banksia marginata**. *Proteaceæ*. Australia.

One of the bottle-brush trees. A small to medium sized tree growing to height of about :0 feet and a spread of 12 feet. Leaves pinnatifid, greenish above and whitish beneath. Flowers borne on dense catkins which look like 'brush'. Flowers July to September. Propagated by seeds as well as by cuttings An ornamental tree valued for its bottle-brush-like flowers.

27. **Betula alnoides,** Birch. Tamil: 'Bodhi Sathva'. *Betulaceae.* Himalayas.

A fairly big sized tree growing with elegance and beauty. Reported to be gregarious in habit in its native regions. The branchlets with

leaves show a hanging tendency which adds beauty to the appearance of the tree. Another peculiarity of the tree is the peeling off of the bark in patches. The male and female catkins are separate.

Propagated by ripe seeds sown as soon as gathered. Grafting and budding can also be adopted as methods of propagation.

An ornamental tree with pendulous branches.

28. **Biota orientalis,** Endl. Chinese Arbor-vitæ. *Pinaceæ.* Persia to East Asia.

Cultivated in China and Japan. A low evergreen tree of pyramidal habit with a much branched trunk, coming up well both at Ootacamund and Coonoor (5,600 to 7,700 feet), perhaps better at Ootacamund (7,700 ft.). The leaves are in decussate pairs. The cones are solitary at the ends of branches. There is a variety *aurea* of this species, which is a much smaller plant with golden coloured leaves at the extremities. Very beautiful tree. Specially recommended for ornamental gardens and parks on the hills, particularly as single specimens in lawns.

29. **Brahea robusta.** *Palmaceæ.* Mexico.

A hardy palm with fan shaped leaves. Suitable for elevation of 6,000 to 7,000 feet. Propagated by seeds.

30. **Bucklandia populnea.** *Hamamelidae.* Himalayas.

The only species of the genus. A big sized robust tree. Comes up well at Coonoor and Ootacamund. Leaves are ornamental in appearance being thickly coriaceous, glabrous, broadly ovate in shape with acuminate apex. The flowers are polygamous. A very quick growing tree with broadly conical crown, attaining a height of about 100 feet with 50 feet spread. The diameter of the trunk measures 2½ feet.

Can be propagated by cuttings of ripened shoots. Valued as an ornamental tree as well as for its hard timber which is used for building purposes. Ornamental because of broad shining leaves and the shape of tree.

31. **Callicoma serratifolia.** *Saxifragaceae.* Australia.

A medium sized tree growing to a height of 50 feet with a spread of 30 feet with spreading branches, leaves green and finely serrated. Creamy white flowers are borne in panicles during August to November.

An ornamental tree fit for lawns as solitary specimens.

32. **Callistemon lanceolatus,** DC. Bottle Brush. *Myrtaceae.* Australia.

This tree grows on the Nilgiris to a height of about 35 feet and equal spread, with trunk diameter of about 1 foot. The leaves are pinnate and the inflorescence is conspicuous, of scarlet colour, and looking like a bottle brush. This species comes up better at Coonoor.

Propagated by seeds and also from ripened cuttings in sand.

Tree considered ornamental because of its scarlet red, bottle-brush-like flowers.

33. **Callistemon rigidus,** R. Br. Stiff Bottle Brush. *Myrtaceae.* Australia.

The tree grows to a height of about 25 feet and a spread of about 25 feet. Branches start almost from ground. Many branchlets hang down giving a weeping appearance. A compact evergreen flowering bushy tree with dark green narrow pointed leaves forming a dense mass and with brilliant red stiff, bottle-brush-like flowers in profusion at the tips of branches which are very showy.

34. **Camellia japonica,** Linn. Camellia. Japanese Rose. *Ternstroemiaceae.* China and Japan.

This is one of the hardiest and loveliest of evergreen large bushes which do well both at Coonoor and Ootacamund. It is a charming tree to adorn the centre of a large bed or a lawn with its double white flowers and spherical natural shape filled with dark green, fairly big sized, serrate leaves, glistening on the upper surface and exposing quite a number of very attractive rose-like flowers and flower buds. The flowers are mostly solitary, but sometimes appearing in clusters of twos and threes. Selected white flowers are prized as button holes. These come up slightly better in Coonoor than in Ootacamund where there is frost occurrence. This will thrive in a cool shady situation, deep rich soil and with thorough mulching with cow manure and compost, some months before flowering. These can be propagated by rooted cuttings; among various other methods.

35. **Camellia reticulata,** Lindl. *Ternstroemiaceae.*

Another garden species, with double purple large sized flowers. Foliage distinct from Camellia Japonica. Gorgeous in appearance like Camellia japonica. A useful material for topiary work.

36. **Camellia Thea.** Assam and Japan. *Ternstroemiaceae.*

An ornamental shaped tree, the top spreading like a fan with numerous outspreading branches, starting almost from ground level. 30—35 feet tall with the same spread.

37. **Castanospermum Australe,** Cunn. Moretona Bay Chestnut. *Leguminosae.* Australia.

This evergreen tree is remarkably quick growing and wide spreading, with masses of green shiny foliage, giving shade to quite a large area. It can grow to about 60 feet height and an equal spread. The flowers are red and very showy during May to July.

Propagated from seeds. Both ornamental and economic. The timber can be used for furniture and cabinet making. The seeds when roasted are edible. Very fine specimens seen in Sim's Park, Coonoor.

38. **Casuarina montana.** Beef Wood. *Casuarinaceae.* Malaya.

A quick growing tree, ornamental due to its pyramidal shape and hair-like jointed leaves, which are modified branchlets. When planted close, the trees are useful as wind-break. Amenable to repeated clippings, these form beautiful hedges of various shapes. Single plants can also be used for topiary work. This is useful as a fuel tree and for reclaiming sandy stretches. It can be propagated from cuttings of half ripened shoots.

39. **Cedrela Toona,** Roxb. Indian Mahogany. Red Cedar. Toona tree. Tamil : Malavembu or Santhana Vembu. *Meliaceae.* India.

This nearly evergreen tree with dark green foliage grows to a height of about 100 feet with a spread of about 60 feet and trunk of 3½ feet diameter on the Nilgiris. The leaves are paripinnate, and the leaflets lanceolate, acuminate. The white honey-scented flowers are produced in terminal cymose panicles. The seeds are winged at both ends. This is a wild tree common in the evergreen forests of Western Ghats and Himalayas. The tree is highly valued for its red, shining, nonsplitting timber. The tree can be propagated by layers, and also by cuttings and seeds. This is a big sized tree. Fine specimens are seen at the Sim's Park, Coonoor. The trees are fairly wild on the Nilgiri plateau, mostly around Kotagiri and Coonoor. Also planted as an ornamental here and there.

40. **Cedrus Deodara,** Loud. Himalayan Cedar. *Pinaceae.* Himalayas.

A large evergreen tree with graceful wide-spreading drooping branches, with dark bluish-green, stiff, needle-like, four-angled clustered leaves, 2 inches long and with cones upto 5 inches, which are produced in May and June. Fine specimens of these are seen at Government Botanic Gardens, Ootacamund. In good surroundings it is known to grow upto 150 feet height.

Propagated from seeds which are difficult to extract from the cones, sown soon after collection. An ornamental tree because of its stately shape. Wood very durable, fragrant and highly valuable.

41. **Celtis serotina.** Hackberry. Nettle Tree. Tamil: 'Kureiya'. *Ulmaceae.* Himalayas.

A middle sized deciduous tree, not fast growing under Nilgiri conditions, growing to 35 feet height and a spread of 25 feet. More than half the lower height of the stem is free from branches and foliage. This is ornamental as a single specimen on the lawns, also giving some shade. The foliage is light green and the leaves ovate to ovate lanceolate. The flowers are inconspicuous. Fruit is a drupe.

Propagated from seeds which are sown as soon as collected. Also by layering and cuttings of ripened shoots. A deciduous ornamental tree.

42. **Chamaerops fortunei.** China Fan Palm. *Palmaceae.* Japan.

An ornamental hardy palm growing to about 40 feet in height. The leaves are fan shaped, split all round into segments towards formation of leaflets. The attractive open leaves about a dozen in number on the crown are borne on stout, short leaf-stalks. Flowering is seen throughout the year in Ootacamund Propagated from seeds, and also by suckers.

43. **Cinnamomum Camphora,** Nees and Eborn. Camphor Tree. *Lauraceae.* China and Japan.

A beautiful bushy dense growing tree, attaining about 70 feet height, equal spread and 8 to 10 feet breadth of trunk with aromatic leaves that are whitish beneath, and with inconspicuous yellow flowers, and 1½ feet thick branches arising almost from ground level keeping the foliage close

to the ground. Suitable for parkway planting. Suited for elevations lower than 6,000 feet. Good specimens are seen at Sim's park, Coonoor.

44. **Cinnamomum Zeylanicum,** Nees. Cinnamon. *Lauraceæ.*

A beautiful tree with foliage as in camphor. The tree is both of ornamental and economic value. Suitable for elevations of about 3000 ft. The bark of this tree produces the cinnamon of commerce.

45. **Cordyline australis,** Hook. Broad Leaf Club Palm. *Liliaceæ.* New Zealand.

This tree grows well in the open both at Ootacamund and Coonoor. At Ootacamund, it measures about 20 feet high. The trunk is much branched. The leaves are stiff, long and sword shaped and dull green in colour. If planted close along both sides of walks, these form a beautiful avenue.

Propagated from seeds or by chinese layers, also by suckers and side shoots.

46. **Corynocarpus laevigata,** Forst. New Zealand Laurel. *Anacardiaceæ.*

An evergreen tree with large glossy leaves. Height of 40 feet with a spread of 25 feet. The creamy yellow flowers are borne in paniculate clusters during May to July. Tree of ornamental value because of its glossy foliage and creamy, yellow flowers. Propagated by seeds which are available during July to September. Also by cuttings.

47. **Cryptomeria japonica,** Don. Japan Cedar. *Pinaceæ.* Japan and China.

A tall pyramidal, stately and quick growing evergreen tree attaining a height of 40 feet, a spread of 30 feet and trunk usually free of branches along the lower part of the trunk. The foliage consists of sharply quadrangular leaves which are closely set on the branchlets, yellowish green in summer and dark-green in winter. The trees are monœcious, the male catkins and cones clustered at the ends of branchlets. Flowers during February–May. Old cones are persistent. This likes a good deep soil and a moist fairly sheltered site. This tree comes up well both at Coonoor and Ootacamund. Propagated by seeds which are available from October to December; also by cuttings of growing wood in sandy soil.

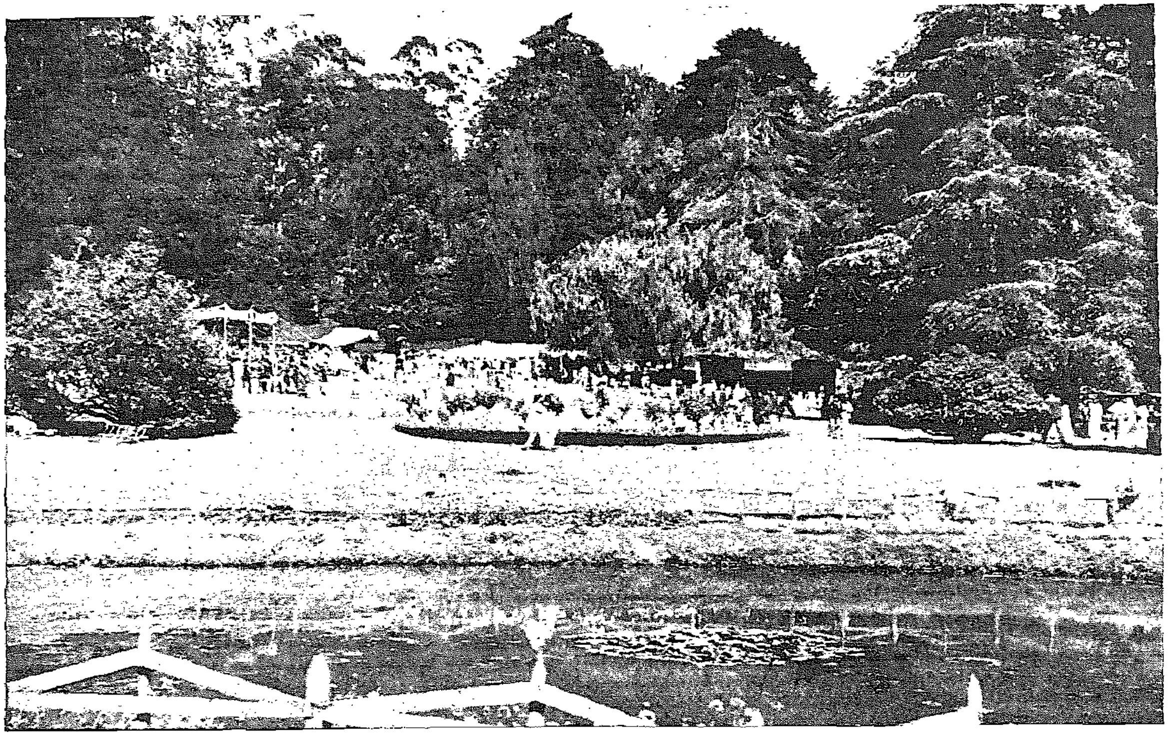
The timber is of very high value for building purposes.

48. **Cupressus funebris,** Endl. Weeping Cypress. *Pinaceæ.* China.

A large tree of striking and handsome appearance, the branchlets and foliage having a pendulous (weeping) habit. The branchlets are distichous. In China, this graceful tree is largely grown in cemeteries, Budhist temples and monasteries. Strobiles are small sized and in numbers. The cypresses can be propagated from seeds which can be collected from August to October and sown by about March – April; also from cuttings of growing or ripe wood. Very ornamental and fit for avenues.

49. **Cupresses glauca,** Lam. Cedar of Goa. *Pinaceæ.* East Indies.

A medium sized pendulous growing tree with spreading branches, sub-pyramidal in shape. The foliage and cones are slightly bluish. Cones are solitary. Comes up fairly well at Ootacamund and Coonoor.



A section of the Government Botanic Gardens, Ootacamund with groups of trees in the background including *Cupressus lawsoniana, C. sempervirens, C. funebris, Cedrus Deodara, Ilex cornuta.*

The tree is common above ghats in West India. Seeds are available for collection during September – November. Tree is of ornamental value.

50. **Cupressus Knightiana,** Mast. *Pinaceæ.* Mexico.

Very ornamental, with conical shaped crown. Branchlets very regularly arranged, fern like, and drooping. Cones with stout, conical pointed bosses.

51. **Cupresses lawsoniana.** White Cedar. *Pinaceæ.* California.

Probably the most beautiful of the genus in full growth, it is a hardy tree with drooping branches highly decorative for lawns. This thrives better at Ootacamund than at Coonoor.

Among the varieties, Fletcheri is an even more ornamental type, with dark green leaves, bearing seeds in abundance, suited to Ootacamund zone.

52. **Cupressus Corneyana,** Mast. *Pinaceæ.* Australia.

A large sized tree with short main trunk 5 to 6 feet thick with pendulous branches. Growth habit and appearance almost like *C. macrocarpa*.

53. **Cupresses macrocarpa,** Hartw. Monterey. Common cypress. *Pinaceæ.* California.

An ornamental evergreen quick growing tree. Most extensively grown cypress in the higher elevations of Nilgiris. Varied uses, as avenue trees, shelter belts for wind-swept localities, hedges, for fine topiary work, excellent specimens of which can be seen in the Palace Gardens and Government Gardens of Nilgiris. Widely used as fuel.

The natural shape is broadly pyramidal. The branches are stout and spread horizontally with dark green closely appressed leaves. Cones are globular and in clusters. The tree grows to a huge size, upto a height of 120 feet. Seeds are available for collection during August to October.

54. **Cupressus obtusa.** Fernspray Cypress. *Coniferæ.* Japan.

A compact tree with a straight trunk. Strobiles solitary. The tree grows to a height of about 50 feet.

The tree is held sacred by the Japanese, and the timber which is strong, fragrant and fine-grained is useful. Trees can be clipped to shape for ornamental gardens.

Seeds are available during September – November at Ootacamund.

55. **Cupressus Lindleyi,** Mast. *Pinaceæ.* Mexico.

The tree grows to a height of about 60 feet at Coonoor, with straight trunk and conical shaped top. Branchlets regularly arranged, of nearly equal length. Cones small, with small pointed bosses.

56. **Cupressus sempervirens,** Linn. Italian or Roman Cypress. *Pinaceæ.* Italy.

A long living, very compact, tall, erect growing tree with a distinctly ornamental and striking columnar shape. The branches are erect with dark green closely appressed leaves. Strobiles are mostly in clusters.

It has succeeded better at Ootacamund than at Coonoor. The shape is beautiful and stately, and the tree is worthy of wider uses for avenues and in gardens.

57. **Cupressus torulosa**, Don. Bhutan Cypress. Tamil: Sambarani maram. *Pinaceæ.* Himalayas.

The tree grows to 100 to 120 feet height, 60 feet spread with a trunk thickness of more than 8 feet, and assumes a beautiful broadly conical shape, with branches starting horizontal and ending with characteristic upward curvature. The leaves are closely imbricate and the branchlets are clustered with cones. Flowering is between February and May. The fruits are long, persistent on the tree. It has drooping leaflets and broad pyramidal crown.

Magnificent specimens are seen at Botanic Garden, Ootacamund, and form stately avenues at Coonoor. Fine groups of them have been planted here and there at Ootacamund, with grand scenic effect.

Very useful as an avenue tree and as a wind belt. Quite ornamental over the lawns. The wood is very durable. The tree is a source of resin.

Seeds are available at Ootacamund for collection during August to November.

58. **Diopsyrous virginiana**, Linn. *Ebenaceae.*

The tree grows to a height of 30 feet and spreads to about 30 feet, with irregular shape, hooked branches, shining broad leaves. More than 40 year old specimens are seen at the Sim's Park, Coonoor. It is quite an ornamental tree.

59. **Dracaena lanuginosa.** *Liliaceae.* Canary Islands.

This tree is grown for the ornamental character of its leaves. The base of the leaves closely grasps the stem. The leaves are sword shaped, the under surface being violet purple in colour. The trunk sometimes branches into two or three.

For pot culture, for centre of beds and rockeries or for growing in clumps, these are well adapted. Propagated by division or by stem cuttings. Comes up well at Ootacamund and Coonoor. A very good ornamental tree.

60. **Elaeocarpus Ganitrus,** Roxb. Bead Tree of India. Tamil: "Rudraksh". *Elaeocarpaceæ.* Himalayas.

This is a tall, evergreen tree, growing to a height of about 100 feet with 60 feet spread and trunk thickness of 4 feet at ground level. Leaves are numerous and lanceolate. From the axil of fallen leaves, the white flowers hang in compact racemes. Fruit is an ornamental drupe about an inch in diameter and marked with five grooves. Propagated largely by ripened shoots with leaves left in them and also by seeds.

61. **Elaeocarpus munroii.** *Elæocarpaceae.* India.

This is another South Indian species common in the evergreen forests of Western Ghats. The tree reaches a height of 20 feet and spreads to about 20 feet. The leaves of this tree are glabrous, ovate-lanceolate and

crenate. Flowers are borne in short racemes which have reddish white petals which are very attractive. Fruit is a drupe with hard flesh. Propagated by seeds. Wood is used as fuel.

62. **Elaeocarpus oblongus,** Gaertner. Nilgiri Mock Olive. Tamil: 'Bikke maram'. *Elaeocarpaceae.* Nilgiris.

A tropical evergreen tree with penniveined leaves and somewhat showy flowers. Young shoots are puberulent. The tree grows to a height of 30–35 feet, spread of 50 feet with trunk thickness of about 2 feet. Leaves are alternate, and broadly elliptic. Old leaves attain rose pink colour. As the leaves get older, first the midribs, then the veins and then the whole leaf gets reddish in colour. Racemes are shorter than the leaves. Fruit is a drupe. This grows wild in the forests of Nilgiris yielding edible fruits which are available in abundance during April to July. Propagated by seeds.

63. **Erythrina Crista-galli,** Linn. The Coral Tree. Cockscomb Tree. *Leguminosae.* Brazil.

A tree carrying terminal spikes of bright mahogany red, sweet-pea-like flowers. Tree grows to a height of 50 feet with a spread of 25 feet. Flowers during November to January. Propagated from seeds or by cuttings of young shoots with heel, in sandy soil. Good for ornamental purposes.

64. **Eugenia arnottiana,** Wight. Umbrella Tree of Ootacamund. Tamil: Naval. *Myrtaceae.* Nilgiris.

This tree is common in the Nilgiri forests. A well grown tree has a height of about 40 feet with nearly an equal spread. Leaves are small sized, shining reddish in colour when tender, and elliptic and acuminate in shape, and drooping. The flowers are in umbels with cream-coloured petals and appear in winter months. The flower buds and edible berries are red, useful for jams. Comes to bearing during February to May. Propagated easily by seeds. One of the very commonest trees by way side or in sholas, in the Nilgiris.

65. **Eugenia Callophyllifolia,** Wight. Tamil: 'Kurunai Naval'. *Myrtaceae.*

At Coonoor, it is a big sized tree growing to a height of 70 feet with a spread of 70 feet. Leaves linear lanceolate, bright green in colour with margin. Flowers dull white in colour and are borne on umbels. When the trees flower in January, the whole tree is clothed with flowers. Fruit is a small berry with a single seed inside; flesh juicy and sweet; can be used for making jams. July to September is the season of fruiting. Wood useful as fuel. Seen wild in the Pykara area (7,800 feet) and suitable as an ornamental.

66. **Eugenia Smithii.** *Myrtaceae.* Chile.

An evergreen medium sized tree, growing to about 30 feet height. The leaves are dotted with glands. The flowers are either terminal or lateral, and are tetramerous, flowering during March–May. The fruit is a berry, red in colour and edible. An ornamental tree yielding edible fruits.

67. **Fagus sylvatica,** Linn. European Beech. *Fagaceæ.* Europe.

An ornamental tall tree with a good shape. Leaves are ovately elliptic, denticulate and hairy when just emerging from the buds. The winter buds are very conspicuous. The flowers are monœcious.

The tree deserves wider attention for planting in parks in Ootacamund area. The Timber is valuable.

Propagated commonly by seed, sown immediately after gathering.

Thrives well at elevations over 5,000 feet.

68. **Ficus elastica,** Roxb. Indian Rubber Tree. *Moraceæ.* Himalayas.

Tree grows to a height of 50 feet, with branches coming off low on the trunk. Leaves are glabrous and shining, elliptic and acuminate. Stiplules are big sized, pink in colour and add to the ornamental nature of the tree. Fruit is sessile and greenish yellow in colour. The tree has some economic importance in being a source of useful latex. The tree can be propagated by air layering, besides by seed.

69. **Ficus macrophylla,** Desf. Australian Banyan. Moreton Bay Fig. *Moraceæ.* Australia.

A fine big spreading tree with glabrous leaves. Saitable for planting in parks. Leaves ovate, oblong, shiny on both surfaces.

Wood useful for cheap furniture, rough planking, doors of huts etc.

Propagated by single eye cuttings inserted in sand, sandy soil or sphagnam moss in good bottom heat under glass. The milky juice should be removed before planting. Cuttings from last season's wood inserted in winter. A very fine avenue tree, among the best of Australian trees. Can resist frost completely.

70. **Fitzroya patagonica,** Hook. f. Patagonia. *Pinaceae.*

A large evergreen tree with slender, spreading branches curving up at extremities, with straight trunk, regularly placed branches, and broadly conical crown. Foliage is dark green, flattened, and cones are produced during December to February. An ornamental conifer with a stately shape.

71. **Frenela rhomboidea.** *Coniferae.* North Holland.

The tree grows to a height of 70 to 80 feet, with a spread of 40 to 50 feet, and trunk thickness of 2 feet. Very useful for hedge, and stands clipping very well. Twigs used for shading of transplanted plants, in the initial stages.

72. **Ginkgo biloba,** Linn. Maiden Hair Tree. Ginkgo. Kew Tree. *Ginkgoaceæ.* North China.

An upright ornamental medium sized curious tree. This is one of the few deciduous conifers and the only species of its genus. Not only is it a beautiful tree but it is interesting as a relic of prehistoric times; the passing centuries and general evolution of flora have failed to alter the original characteristics of this unique tree. The curious fanshaped, maiden-hair-fern-like leaves turn clear yellow before failing before the winter.

Propagated by seeds. Also by layorirg and cuttings of green or ripe wood. Budding and grafting are also feasible. An ornamental tree which is also of botanic interest. Solitary plantings can be made with picturesque effects.

The fruits are edible and esteemed as food by Chinese and Japanese who use the kernels which have a sweetish, resinous flavour.

The Government Botanic Gardens, Ootacamund is one of the few places in India, which has fine specimens of the tree.

73. **Grevillea Banksii,** R. Br. *Proteaceæ.* Queensland.

A very small woody tree growing to a height of 10 feet with a spread of 12 feet. Leaves pinnately veined and whitish beneath. Flowers are borne in racemes which are comb like and signal red in colour. Flowers during February to July. Fruit is an oblique follicle, and persistent. Very ornamental because of its comb like flowers. Highly decorative for lawns as single specimens. Propagated from seeds and cuttings. Beautiful specimens, though small.

74. **Grevillea Hilliana,** F. Muell. *Proteaceæ.* Australia.

This medium sized tree with a nearly spherical shape, of about 20 feet height, 15 feet spread and 6 inches trunk thickness, comes up well both at Ootacamund and Coonoor. Leaves are ornamental, long, spoon shaped, thick, with wavy margin. Infloresence is a long cylindrical raceme of white spike-like clusters of flowers. Flowers during March—May. Fruit is an oblique follicle and persistent.

Grevilleas are propagated from seeds. Can also be propagated by cuttings of half ripened wood. An ornamental tree; when in flower, clothed with beautiful long infloresences resembling brushes.

75. **Grevillea robusta,** Cunn. Silver Oak. *Proteaceæ.* Australia.

This is a fairly large, rapid growing evergreen flowering tree with fern like deeply pinnatifid leaves and attractive comb-like orange coloured flowers in racemes. Fruit is a follicle.

This tree is cultivated for regulating shade in tea estates in the Nilgiris. It is useful also as fuel tree and for its timber.

Grows well at attitudes over 3,000 feet. Also worth growing as avenue trees.

76. ***Heptapleurum racemosum,*** *Bedd. Tamil: 'Kanneemaram'.* *Araliaceae.* South India.

This is a tree commonly found in sholas around Coonoor. It has stout branches and the scars of the fallen leaves are marked. The leaf is pinnate, with 5 to 7 leaflets, entire, with wavy marin. The tree grows to a height of 35 to 40 feet, with spread of 15 feet. Flowers are attractively white and in racemed spikes. This tree does not thrive at elevations above 6,000 feet. May to June is the normal time for flowering. Propagated by cuttings. An ornamental tree, with its pinnate leaves and flowers.

77. **Heynea trijuga,** Roxb. Tamil: Karaikaruvilangam. *Meliaceae.* India.

A medium sized teee with small, pale cream flowers in corymbose panicles with orange-yellow stamens massed in the centre. Grows wild

in Nilgiris, and is found on roadsides in Coonoor and at lower levels. Wood mostly used for fuel.

78. **Hymenosporum flavour,** F. Muell. *Pittosporaceæ.* Australia.

A tall growing evergreen tree, coming up well in Ootacamund area with handsome foliage and profuse yellow scented flowers appearing in January to April, in such abundance and pleasing yellow colour, rarely found in other trees. Leaves are long, obovate and entire. Flowers about an inch across. The tree has ornamental value.

79. **Jacaranda mimosæfolia,** D. Don. Green Ebony. *Bignoniaceæ.* Brazil.

A favourite ornamental flowering tree on the higher elevations of Nilgiris, with its delicate fern like foliage, and beautiful large panicles of lavender-blue flowers. One of the best of foliage and flowering trees. Makes a gorgeous sight when in flowers particularly in Coonoor area with the beginning of summer.

This deserves to be planted more widely. Highly suitable as an avenue tree, and as specimens on lawns.

Propagated from seeds, also from cuttings from the half ripened shoots in sand over sandy peat with heat. Timber useful for sports goods as a substitute for willow.

80. **Juniperus Procera,** Hochst. *Pinaceae.* Tropical Africa.

It is among the tallest of *Juniperus* species, growing in suitable places in the Nilgiris to a height of 100 feet, spread of 50 feet with straight trunk, and main branches 2 feet thick, horizontal, and arising almost from ground level, and sub-branches inclined terminally upward. Obovate crown. Tree ornamental.

81. **Juniperus virginiana,** Linn. Red Cedar. *Pinaceae.* North America.

A hardy and ornamental tree which grows upto a height of about 40 feet, with an equal spread, having branches, arising almost from ground level. Male and female cones are borne separately. Wood durable, resists the action of moisture and can be used for building purposes, and manufacture of pencils. The wood, twigs, and fruits, are burnt as incense.

Propagated from seeds. It is better to remove the pulp by macertion or by soaking with ashes for a few days, prior to sowing. Also raised from green cuttings in sand.

82. **Koelreuteria formosana.** Flame Golden Rain Tree. *Sapindaceae.* Formosa.

The tree is semideciduous, grows to a height of 60 feet with an equal spread and a trunk thickness of 2 feet. It bears in spring panicles of small, yellow flowers which are followed by large curious bladder-like seed pods that closely resemble heavy panicles of gorgeous pink Bougainvilleas. Very ornamental when in bloom. Fine specimens in Coonoor. The tree also provides good shade.

Another section of the Government Botanic Gardens, Ootacamund. The trees include *Cupressus lawsoniana* *Var. Fletcheri*, *Quercus montana*. *Q. serrata*, and *Cupressus torulosa*.

Propagated by seeds, layering, soft stem cuttings of young shoots, and by root cuttings.

83. **Lagerstroemia indica,** Linn. Crape Myrtle. Indian Lilac. *Lythraceae.* China and India.

One of the small trees, with showy mauve coloured terminal flowers borne profusely, and attractive even from a distance. It comes up better at Coonoor area than in the Ootacamund area. It attains a height of about 20 feet with a spread of 15 feet. Grown in gardens, every where in India for the mauve coloured flowers, the petals of which are curled.

Propagated from seeds, layers and cuttings of small firm side-shoots. Very showy and ornamental.

84. **Leptospermum flavescens,** Smith. *Myrtaceae.*

A small tree, attaining a height of about 25 feet and a spread of 15 feet with tiny and almost erect branches, attractive foliage and profusely produced axillary pentamerous flowers, solitary or in clusters during February–March both in Ootacamund and Coonoor. Ornamental in appearance with its regular shaped crown.

85. **Leptospermum scoparium,** Forst. *Myrtaceae.* Australia. New Zealand.

A medium sized graceful and ornamental species with tiny rigid and rather erect branches and small narrow linear leaves. Attains a height of about 35 feet and 20 feet spread. The bark peels off in patches. Small white flowers are produced from about April to June. Comes up well in Ootacamund and Coonoor areas. Propagated by seeds and root suckers.

There is a variety *Nicholli,* Turril., which is more attractive and ornamental with carmine coloured star shaped flowers and tinted bronze leaves worth introduction on the hills.

86. **Ligustrum lucidum,** Ait. Chinese Glossy Privet. *Oleaceae.* China and Japan.

A small sized deciduous tree grown for the handsome dark green glossy foliage and small creamy white fragrant flowers in profuse terminal panicles 6 inches long. The tree is much branched, and if planted close and trained, forms a good hedge. Flowers in March–April. The fruit is a berry.

The privet hedges are well known in California and trained into different conventional forms.

Propagated from seeds, division or cuttings of green or ripe wood.

Very ornamental on account of its foliage and creamy white flowers.

87. **Macadamia ternifolia,** F. Muell. Queensland Nut. *Proteaceae.*

A tree of moderate size, upto about 40 feet height, and 15 feet spread, with a straight trunk and dense, rigid, prickly dark green foliage, somewhat resembling chestnut. The hard shelled nuts have edible solid meats of delicious flavour. Popular as an ornamental tree. Wood pliable and fit for making cases and boxes.

88. **Macaranga indica,** Wt. *Euphorbiaceæ.* India.

Tall tree growing to a height of 70 to 80 feet, and a spread of 25 to 30 feet, with an almost cylindrical trunk and uniformly placed branches. Quite ornamental.

89. **Magnolia Campbelli,** Hook. f. and Thoms. Lily Tree. *Magnoliaceæ.* Himalayas.

The magnolias are highly ornamental. This is a medium sized, handsome deciduous tree with very attractive big sized terminal flowers. When in flower, the tree is more or less leafless. Flowers are rose coloured. The production and size of flowers are better in Ootacamund area than in Coonoor area. The flowering commences during December, when few shrubs or trees are in flowers and lasts for a long period upto May. This tree has not set seed either at Ootacamund or at Coonoor. It is said that this Indian forest tree in its wild state attains great size.

The magnolias can be propagated from seeds, with the covering macerated in pulpy species; also by green cuttings with heel, or by layers. Named varieties are propagated by grafting.

90. **Magnolia grandiflora,** Linn. Tree Lotus. Laurel Leaved Southern Magnolia. *Magnoliaceæ.* North America.

This is a heavy foliaged, evergreen, medium sized, flowering tree which grows upto a height of 80 feet, and has been coming up well both at Ootacamund and Coonoor. The leaves are big sized, broad and shiny. The large slightly scented, waxy white, goblet shaped single flowers, 6 inches or more across, begin appearing in June. Seeds are available from August onwards. Needs a warm sheltered position. Very ornamental and highly decorative.

91. **Melaleuca Leucadendron,** Linn. Myrtaceæ. Cajeput Tree. Swamp Tea Tree. *Myrtaceæ.* Australia.

An evergreen, slender, medium sized, flowering tree with willowy branches, and narrow grey green foliage. The tree grows to a height of 60 feet; with a tall and straight trunk and ovate shaped crown. Creamy white bottle brush flowers are borne several times a year.

Highly decorative. Yields the well known green aromatic cajeput oil which is used as a repellent against mosquitoes, and has important medicinal uses. The bark is pale buff and peels off in many thin papery layers which are very durable and almost impervious to water. Some of the sacred writings have been inscribed on such pieces of bark.

Propagated from seeds, and also by three inch long cuttings inserted in a compost of peat and sandy loam.

92. **Meliosma arnottiana,** Wight. Tamil 'Hulimakai'. *Sabiaceæ.* Nilgiris.

A medium sized tree with s spreading head, growing well in the sholas of Nilgiris of higher elevations. Leaves pinnate, ovate-lanceolate, acute, tinged pinkish brown when tender. New growth in March. Underside of leaflets and panicles rusty, pubescent. Flowers crowded, cream coloured, on very short pedicels. May-June is the flowering period. Ornamental with its shiny green foliage. Propagated by seeds.

93. **Meliosma wightii,** Planch. Bastard Mango. Tamil: Todo. *Sabiaceæ.* Nilgiris.

This is usually a small tree with tall pyramidal panicles of cream coloured small flowers, recalling those of mango. Very wild on the Nilgiri hills. Leaves shiny green and slightly serrate. A very ornamental tree.

94. **Michelia Champaka,** Linn. Champak. Tamil: Shanbagam. *Magnoliaceæ.* India.

A large evergreen tree with young silky shoots. Flowers yellow or orange, strongly scented, 2 inches across, perianth leaves 15. Seeds are brown. Grows wild in Western Ghats.

The olive brown wood takes a good polish, does not easily rot as it contains a bitter deliquescent salt, and is used for cabinet making, ship building, carriages etc. Flowers yield an oil "Champaca Oil" used in perfumes. Flowers also yield a dye which is used for dyeing silk and cotton fabrics.

The michelias are propagated from seed, and also from cuttings of growing wood in sand medium. An economic and ornamental tree.

95. **Michelia excelsa.** *Magnoliaceæ.* Himalayas.

A medium tree growing to a height of 30 feet, with a spread of 25 feet, with linear green leaves which are thick. Flowers are white, scented, 4 inches across and appear in June to August in the season. Wood is said to be of value for building purposes.

96. **Michelia nilagirica,** Zenk. Tamil: "Kattu Shanbagam". *Magnoliaceae.* Nilgiris.

A tall growing tree with silky buds. Grows to a height of 90 to 100 feet, 40 to 45 feet spread with a trunk thickness of about 2 feet. The tree grows larger in Ootacamund area than in Coonoor area. Leaves short and bluntly acuminate. Sweet scented, cream coloured flowers are in axillary branchlets, 1½ inches to 2 inches across. Perianth leaves usually 12. Fruits red, and seeds bright scarlet in colour. Very common on all the higher sholas, above 5,500 feet, and wild on the Nilgiris. Timber useful.

97. **Mimusops Elengi,** Linn. Bullet Wood. Tamil: Mahila. *Sapotaceæ.* India.

A large tree with leaves, wholly glabrous, shining, elliptic and shortly acuminate. Flowers are white, fragrant and appear from January to April. Fruit is ovoid with one seed. The dark red strong wood is considered to be useful for bridge construction, shaft, axles etc. An aromatic volatile oil is obtained which is used in the manufacture of perfumes. The oil obtained from the seeds is said to be of medicinal value. Propagated by seeds.

98. **Oreodoxa regia,** HBK. Royal or Bottle Palm. *Palmaceae.* West Indies.

A tall graceful palm growing to height of thirty feet with fine fan shaped foliage and smooth trunk which tapers near the crown giving the "bottle shape". Flowers during April—May. A very graceful palm for avenues and groupings. Seen to do very well at Coonoor.

99. **Phœbe paniculata,** Nees. Tamil: Sudalan. *Thymeleaceæ.* Nilgiris and Himalayas.

A tall evergreen tree with alternate penni-nerved leaves and with a characteristic vase shape. Young shoots covered with rusty tomentum. Flowers are borne in panicles of white flowers during December to May. This tree grows wild on the Nilgiris and wood is used as fuel. An ornamental tree.

100. **Phœnix canariensis,** Hort. Canary Date Palm. *Palmaceæ.* Canary Islands.

This hardy, ornamental, rapid growing, stately palm producing a lot of side ruckers is one of the best for out-door planting. It grows over 30 feet in height with a spread of nearly 20 feet. The fronds are nearly similar to those of the dwarf types of coconuts. The leaf is about 15 feet to 18 feet long and drooping. Leaves are crowded at the crown. In groups these palms produce rare ornamental effect. When in flower, this palm is full with yellow flowers, borne on spadices. Very ornamental when planted near lake margins and in groups for landscape effects. Suitable for lining parkways. Beautiful specimens are seen in Sim's Park, Coonoor.

101. **Photinia lindleyana,** Wight and Arnott. Lindley's Rowan. Chinese Hawthorn. *Rosaceæ.* Nilgiris.

A middle sized tree, growing to about 20 feet height, with shining foliage. Leaves are alternate, ovate, with serrate margin turning orange red when ripe. Cattle eat the leaves. Small white flowers are borne in corymbs during March – May. This tree has run wild on the Nilgiris on the Downs and at Coonoor (6,000 feet). Wood mostly used as fuel.

The photinias are propagated from seeds or from half ripened cuttings.

102. **Photinia notoniana,** Wight and Arnott. Common Rowan. *Rosaceæ.* Nilgiris.

Another medium sized tree with spreading branches and white flowers tinged with pink colour. The trunk is very crooked and twisted. Bark rough and dark in branches. Branchlets angular. Flowers are cream white, borne in terminal panicles which are very attractive. A wild ornamental tree of the Nilgiris.

103. **Pieris ovalifolia,** D. Don. *Ericaceae.* Nepal.

A small deciduous tree, coming up well at Ootacamund and Coonoor, grown chiefly for its ornamental, small sized flowers in clusters. Leaves elliptic oblong and fairly big sized. The deciduous nature is striking at Ootacamund. Small white flowers are produced in abundance in axillary racemes during October and November. At Coonoor, the tree is full of flowers in May and the flowers have slight fragrance. Fruits are small round berries, persistent for a long time on the tree. In winter, it is a sight to see the numerous clusters of small fruits covering the tips of branchlets.

104. **Pinus Canariensis,** C. Smith. Canary Pine. *Pinaceæ.*

Grows to a height of about 50 feet, with a spread of about 20 feet with straight trunk, and straight branches placed angularly and conical shape of top altogether forming an ornamental appearance.

The pines are propagated by seed. Seedlings are usually shaded the first season. Grafting, particularly *veneer*, is a feasible method.

105. **Pinus caribea,** Morelet. Slash Pine. Swamp Pine. *Pinaceæ.*

A tall growing pine, suitable also for swamps with horizontally spreading branches forming a broad compact head. At Coonoor, the tree grows to a height of about 40 feet, with a comparatively slender trunk. Leaves are long, about 8 inches, acute, dark-green and lustrous. Cones short, peduncled, and are about 5 inches long.

A very ornamental pine and when grown closely serves as a good wind belt. Propagated by seeds which are available during September to December.

106. **Pinus edulis,** Engelm. Nut Pine. Pinyon. *Pinaceæ.* Himalayas.

On the Nilgiris, it is a small tree with horizontal branches. Leaves are much shorter, when compared to other pines, long, dark green and rigid. A very slow growing pine both at Ootacamund and at Coonoor. Seeds are reported to be edible. An ornamental pine with edible seeds.

107. **Pinus longifolia,** Roxb. Longleaved Pine. *Pinaceæ.* India.

A tall growing, eminently gregarious pine with branches symmetrically whorled high up the trunk forming a round head of light foliage. The bark is thick, cut by deep fissures into large plates. Thrives equally well both in Coonoor and Ootacamund areas. Leaves are thickly set, slender, glossy green and persistent. Male catkins are produced in September. Cones are formed in May and are solitary or in whorls. They ripen in October.

Highly valuable for extraction of resin and turpentine.

108. **Pinus Montezumae, Lamb.** Soledad Pine. *Pinaceae.*

A very variable species with numerous synonyms. This ornamental tree is grown for the picturesque shape and evergreen foliage. The tree grows to a height of 60 feet with a straight trunk. Branches are symmetrically placed and crown is regular obovate shaped. The leaves are dark green, fine and rigid, 6 to 10 inches long, and hang with the conspicuous erect growing cones, which are long and slightly pyramidal in shape. Tree with a very ornamental shape. Very good specimens at Coonoor. Worthy of wider attention on the Nilgiris.

109. **Pinus palustris,** Mill. Long Leaf Pine. Southern Pine. *Pinaceæ.* South America.

A tall growing pine. At Coonoor, the tree has grown to a height of about 120 feet, a spread of 60 feet with trunk thickness of 4 feet and more. The tree is very ornamental with its shape, and needle like

leaves in clusters. This is also important as a timber tree. Easily propagated from seeds, which are best collected during May – July.

110. **Pinus patula.** Jelecote Pine. *Pinaceae.*

A small ornamental pine with stiff green needles. Has a stately shape. The needles are 6 to 8 inches in length, and the bark splits into many pieces. Cones are produced during April to July. Propagated easily by seeds. A good ornamental tree, specially decorative on lawns as single specimens.

111. **Pinus Sabiniana.** Digger Pine. Bull Pine. *Pinaceæ.* California.

A medium growing pine tree of 50 feet height with recurved branches bearing stiff dull green needles which are rather sharp and are 8 to 10 inches in length. Cones are produced in April – June. Easily raised by seeds. A very ornamental tree. Not so good in Coonoor area.

112. **Pittosporum floribundum.** Tamil: Kattu sampangi. *Pittosporaceæ.* Australia.

A small ornamental tree with glistening leaves having a wavy margin. The underside of the blade is paler than the upper side. Flowers yellow in colour and in dense corymbs are attractive during January – March.

113. **Podocarous elongata,** L'Her. *Taxaceæ.* Cape of Good Hope.

A tall growing tree with small leaves which are whitish beneath and shiny. The tree grows to a height of 50 feet and an equal spread, with a semi-globose crown. The cones are produced as terminal clusters of whitish colour. The bark peeling very characteristic. Timber is said to be of immense use in building purpose. Very ornamental on account of the shape of crown and shiny leaves in clusters. Propagated by seeds.

114. **Podocarpus macrophylla,** Don. Shrubby Yew. Podocarpus. *Taxaceæ.* Japan.

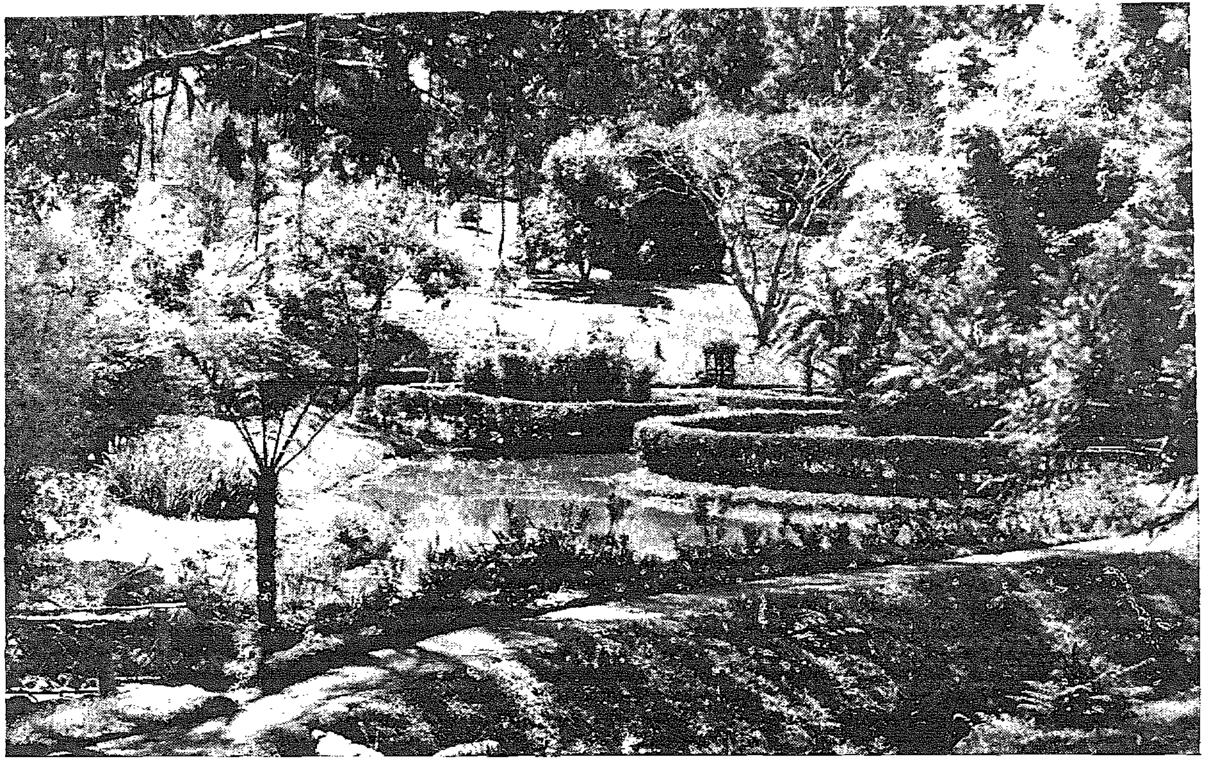
A tree with ornamental foliage, scarcely looking like a conifer. The branches spread horizontally with pendant branchlets. Leaves are alternate, lanceolate, narrowed towards both ends and dark green, with the underside of the leaves pale green. An ornamental conifer. Grows better in Ootacamund area than Coonoor.

The podocarpuses can be propagated from cuttings of firm wood.

115. **Podocarpus taxifolia,** Kunth. Yew Leaved Podocarpus. *Taxaceæ.* Andes.

An evergreen small tree with handsome attractive linear narrow densely packed foliage, almost sessile. This comes up well both in Ootacamund and Coonoor areas. The tree grows to a height of 25 feet and an equal spread. The branches are all ascending and form a V-shaped crown. Flower spikes are axillary. Flowers in Ootacamund during September – October.

This tree can be propagated by cuttings. Very ornamental with its vase shaped crown and is a good decorative material for lawns.



Around the Sim's Park lake. The trees include the tree fern *(Alsophila australis)*, *Albizzia stipulata*, *Cupressus knightiana*, and *Phœnix canariensis*.

116. **Pomaderris apetala,** Labill. *Rhamnaceæ.* Australia.

A tree highly tomentose with woody branches, thick lanceolate leaves. Flowers borne on panicles 2 to 5 inches long, white, very attractive and devoid of petals. Leaves useful as cattle fodder.

117. **Prunus acuminata,** Michx. *Rosaceae*: Himalayas.

A shapely specimen with acuminate leaves which are highly serrate. Flowers white, always sloitary. Propagated by seeds. Timber is good though not of great size. An ornamental tree too.

118. **Prunus Lauroceracus,** Linn. Cherry Laurel. *Rosaceae* Himalayas.

A small tree with ornamental foliage of glossy leaves. Unrestricted specimens reach a height of 40 feet. They are good shade trees, blooming profusely when grown in this form. The flowers are white and slightly fragrant.

They are well adapted to shearing and shaping into pyramids, columns, globes etc. as well as for hedges. A good ornamental tree. Propagated by seeds and cuttings.

119. **Prunus Pissardii,** Koehne. Purple Leaved Plum. *Rosaceae.* Persia.

A very ornamental small sized tree having bush like growth, with rich purple leaves, bluish tinged white blossoms appearing in profusion, and wine red fruits. The ruby red leaves darken to purple as the leaves get older.

A very desirable plant for gardens of higher elevations.

120. **Prunus Puddum,** Wall. Himalayan Cherry. *Rosaceae.* Himalayas.

A large sized tree with comparatively tiny branches. The bark peels off in horizontal strips. Leaves are glossy ovate and sharply serrate. Flowers appear first before the leaves, in this deciduous tree. Flowers are rose red or white in umbellate fascicles. Fruit is yellowish red. This plant comes up better at Coonoor than at Ootacamund. When in flower, this tree is covered fully with flowers without much foliage and is one of the most attractive trees in the Coonoor area during the period of flowering. Useful for avenues, as specimens on lawns, or for planting in groups.

121. **Prunus serrulata,** Lindl. *Rosaceae.*

A middle sized tree with ornamental foliage and white flowers, and with spreading branches giving very good shade during the summer months. The tree grows to a height of 80 to 90 feet with a spread of 50 feet and trunk thickness of 2½ feet and more.

Leaves are large, ovate to obovate, acuminate and roughly dentate when tender. The underside of the leaf is of lighter green colour. Leaves are pubescent along the petiole and undersurface, and turn yellow before shedding. New growth flush is produced in March. A good shade giving tree of stately shape. Comes up better at Coonoor than at Ootacamund.

122. **Pygeum wightianum.** Tamil: "Attanari Kongu". *Rosaceae.* South India.

A large tree with glabrous leaves which are brown beneath, elliptic or elliptic-lanceolate. Racemes axillary and finely pubescent. Flowers from November to June. Ovary has a ring of hairs at the base. Grows wild in the forests of Nilgiris. Wood is used for crude furniture and as fuel.

123. **Pyrus baccata,** Linn. Crab Apple. *Rosaceæ.* Siberia.

A graceful deciduous shrub-tree with a small trunk with profuse V-shaped branches forming a round compact crown at the top. Leaves are ovate to ovate lanceolate, finely serrate. The white handsome showy flowers freely appear with the leaves in March—April at Ootacamund. Fruit is red or scarlet, small, and roundish. It is useful as rootstock for apples (*Pyrus malus*). The tree grows to a height of about 22 feet. An ornamental and economic tree.

124. **Quercus Cerris,** Linn. Turkey Oak. *Fagaceae.* S. E. Europe. Asia Minor.

It is an ornamental tree, with handsome foliage. At Ootacamund, this is a tall tree with short branches forming nearly pyramidal crown. Leaves are ovate-oblong, pinnatifid, with rough upper blade. Grows well in Ootacamund area. Highly valued for its timber.

The Quercusus are propagated generally from seeds. Evergreen species can be grown from cuttings. Grafting is also sometimes adopted. The acorns are said to be used as cattle feed in South Africa.

125. **Quercus coccinea,** Muench. Scarlet Oak. *Fagaceae.* Mediterranean region.

A tree growing to a height of 40 feet with a spread of 31 feet with pyramidal branches and leaves which are linear and serrate. Flowers during April—June. Propagated by seeds. A highly ornamental tree. Timber valuable for various purposes.

126. **Quercus griffithii.** *Fagaceae.* Himalayas.

A large, deciduous, gorgeous tree. Leaves coriaceous, lanceolar with serrate margin. Flowers in solitary catkins appearing in November and January. Propagated by seeds. The tree coppices freely, and can be used for firewood.

127. **Quercus Ilex,** Linn. Holm or Holly Oak. Evergreen Oak. *Fagacaee,* Mediterranean region.

A medium sized evergreen tree suited for growing in Ootacamund area. The tree has a spherical head. Leaves are small sized, glabrous with spiny revolute margin, resembling those of *Ilex Cornuta,* but with more numerous and small sized spines. The foliage is quite ornamental. Flowers during April-June, in white catkins. A tree decorative for lawnsl.

128. **Quercus incana.** *Fagaceae.* Nepal.

A medium sized evergreen, gregarious tree, with attractive foliage. The gray leaves are mucronate with sharp teeth in the margin. The tree

grows to about 45 feet height with 45 feet breadth and 2 feet trunk-diameter. Catkins are produced during February – April.

The species coppices freely. Wood is an excellent fuel. Propagated by seeds.

129. **Quercus laurifolia,** Michx. Laurel Oak. *Fagaceæ.*

One of the most beautifully shaped trees, with regular ovate shaped crown, thick set branches, clothed with ornamental deep green foliage permitting hardly any sunlight to creep through. Considered highly valuable for shade, as avenue trees and as single specimens. The tree grows to a height of 24 to 25 feet with about equal spread.

130. **Quercus macrocarpa,** Michx. Overcup. Mossy Cup. Bur Oak. *Fagaceae.* Japan.

A deciduous tree with big sized, big lobed leaves. The tree at Coonoor is 35 feet tall, 50 feet broad and 1½ feet in trunk diameter. Flush and flowers during March—May. The tree is very ornamental. Timber useful.

131. **Quercus montana,** Willd. Chestnut Oak. *Fagaceae.*

A tree with lot of branches growing upright from the base. Leaves yellowish green above and paler underneath, slender stalked, oblong, lanceolate and coarsely toothed, with asymetrical halves on either side of the midrib. Propagated by seeds. An ornamental tree. Wood used as fuel.

132. **Quercus serrata,** Carruth. *Fagaceae.* China and Japan.

A well known attractive deciduous tree with branches spreading over 60 feet, height of 80 feet, and trunk thickness of 4½ to 5 feet. Sometimes spread is even more than height. There are numerous large pores and cracks in the bark. The youngest shoots are clothed with soft hairs. Leaves are elliptic, lanceolate and shining with long and slender petioles. Flowers during February – April at Coonoor along with new shoots. A tree of both ornamental and economic importance. Timber is very useful. The lower branches start off horizontally, at low height and form good shade Beautiful specimens at Sim's Park, Coonoor. Has ornamentally shaped crown.

133. **Quercus Sessiliflora,** Salisb. Durmast Oak. *Fagaceæ.* Europe.

A tree growing to a height of 50 feet with branches spreading upto 70 feet, with trunk thickness of 3 feet, strong thick branches. Leaves are linear, serrate and pubescent. Flowers during April – May. Timber useful.

134. **Quercus Suber,** Linn. Cork Oak. *Fagaceae.* Europe and North Africa.

A tall evergreen tree with broad head, and corky fissured bark. The leaves are ornamental, ovate, subcordate at the base and roughly serrate with irregular lobes, about 3 inches long. Comes up well at Ootacamund. The bark of this tree constitutes the cork of commerce. An economic tree. Timber used for shafts.

135. **Quillaja Saponaria,** Molina. Soap Bark Tree. *Rosaceae.*

A beautiful birch-like tree having spreading branches with bark which peels off easily. The leaves are lanceolar and serrate. The white panicles of flower are borne in November to January. The powdered bark is used as substitute for soap. Bark also used in medicine. An ornamental tree which yields also useful bark.

136. **Rhopala crenata.** *Proteaceae.* Brazil.

Large tree, 80 feet high, 50 feet broad, and of trunk diameter 3 to 3½ feet with cylindrical main trunk and straight branches starting at low height of 2 feet to 3 feet from ground.

Symmetrically spread, numerous branches most of which arise at almost same level, contribute to an ornamental appearance. Good for shade and for wide avenues.

137. **Rhododendron arboreum,** Smith. Rose Tree or Christmas Tree. *Ericaceae.* Himalayas. South India (Nilgiris).

A medium hardy tree with rough bark, conspicuous in the Nilgiri forests with deep crimson or white flowers. Trees 30 feet high, 40 feet spread, with trunk diameter of 2 feet. Leaves are elliptic oblong, with thick coating of very minute hairs. Flowers are deep crimson coloured, about the size of a rose, borne in corymbs, appearing during December to April, generally giving a good display of flowers in alternate years. Plants are propagated by seeds and also by layers. Useful plant for avenue purposes. Also useful as solitary specimens on lawns. Quite common everywhere in and near Ootacamund.

138. **Rhododendron ponticum,** Linn. *Ericaceae.* Asia Minor. Syria.

This is a smaller tree than *R. arboreum,* with elliptic leaves. The flowers are in clusters and are light violet coloured. This comes up well at Ootacamund. Propagated by seeds. It can also used as a root stock for grafting tender kinds of rhododendrons.

139. **Rhus succedanea,** Linn. Japanese Wax Tree. Sumack. *Anacardiaceae.* Himalayas. China. Japan.

These are small, ornamental trees grown for their elegant form and foliage. Leaflets are opposite, entire, ovate-lanceolate, long, acuminate and lustrous above. Yellowish flowers are borne on slender drooping panicles. Fruit is a drupe.

In Japan, wax obtained from the fruit is used for making candles.

140. **Salix balylonica,** Linn. Napoleon's (Weeping) Willow. *Salicaceae.* Caucasus.

Tree highly deciduous at Ootacamund. Has ornamental foliage. This shows the weeping habit, though the correct "weeping willow" is '*Salix elegantissima*'. It is fairly tall. Leaves linear, and alternate at the base. This species is dieocious. This tree is often grown in cemeteries in Europe and is useful for margins of ponds.

Propagated by cuttings of ripe wood. Wood is a potential source for the manufacture of sports materials.

141. **Salix heterophylla.** Willow. *Salicaceae.* Europe.

Another species growing well at Ootacamund. A tall tree about 65 feet high, larger than *S. babylonica,* with a medium spread, and globular shaped form. There is no 'weeping' habit. Suitable for margins of ponds.

142. **Saurauja nepalensis,** *Ternstroemiaceae.* Nepal.

A small tree with pretty leaves and cluster of pink flowers, very effective as a back-border tree. The branches end in tufts of big sized, strongly serrate, ovate-lanceolate leaves about 10 inches long. The midrib and the secondary nerves are conspicuous and have an ornamental effect. Flowers are pink in showy panicles. Flowers during November—January in Ootacamund. Very ornamental and fit for lawns. Another allied species, *S. fasiculata,* a native of Himalayas is a small tree producing large quantities of pink flowers and with pretty foliage worth introduction.

143. **Schima wallichii.** *Ternstroemiaceae.* Himalayas.

A tall quick growing tree with corky bark, growing to a height of about 80 feet, with a spread of about 20 feet. Leaves are big sized, deciduous and pale yellow at the time of shedding. A good part of the trunk is free and erect. Scented, fairly big sized, white flowers are produced in April – May.

The tree coppices readily and the wood is a good fuel.

144. **Schinus Molle,** Linn. Californian Pepper Tree. *Anacardiaceae.* Tropical America.

An evergreen ornamental tree, very popular in California. The arched rounded top and the bipinnate long drooping leaves heavily borne on the pendulous branches are very attractive. The tree grows to perfection at Ootacamund. Small flowers in conical panicles are seen in March – April.

A highly valued, lawn and avenue tree which could be recommended for Ootacamund or for similar elevations. Propagated by seeds or by cuttings.

145. **Spathodia campanulata,** Beauv. Fountain Tree. Bell Flambeau Tree. *Bignoniaceae.* Tropical Africa.

This evergreen tall flowering tree is attractive because of its spectacular orange red flowers appearing twice a year, and its beautiful dark green foliage. It resists drought. If it happens to be frozen down, it springs back from its roots quickly. The unexpanded flowers contain water and hence the name 'Fountain'. Propagated by seeds or cuttings.

146. **Spondias axillaris.** *Anacardiaceae.* West Indies.

This is a tall evergreen tree, the brownish bark of which peels off in long flakes. The tree grows to a height of 100 feet, spread of about 50 feet and trunk thickness of 1½ to 2 feet. Leaves are opposite and pinnate, with leaflets 6 to 8 pairs per leaf, ovate lanceolate and accuminate. Flowers are in axillary panicles, and appear in February to May. Fruit is an edible drupe, yellow when ripe.

Propagated by seeds or by large cuttings of growing wood. The wood is mostly used as fuel. Ornamental tree. A good avenue or shade tree. Good at Coonoor.

147. **Sterculia acerifolia,** A. Cunn. Flame Tree. *Sterculiaceae.*

A handsome deciduous tall tree with large pendulous clusters of scarlet flowers appearing in May–June. The leaves are very shiny. Propagated by seeds or by ripened cuttings taken with leaves. An ornamental tree quite showy with large masses of red brilliant blossom, appearing when bare of leaves. Fine for streets and as specimens on lawns.

148. **Symplocos spicata,** Roxb. *Styraceae.* Nilgiris.

This is a middle sized tree, the branches of which are of spreading nature, often curved. The leaves are coriaceous, acuminate and serrulate. The cream-coloured sessile flowers are produced in axillary spikes during September–November. Fruit is a ribbed drupe. This wild tree of the Nilgiris is seen in Kotagiri, Coonor and lower down to 3,000 feet.

149. **Syncarpia laurifolia,** Ten. Turpentine Tree of Queensland. *Myrtaceae.* Australia.

A tall, large, handsome tree growing to a height of 120 feet with a spread of 40 feet, and with an erect symmetrical habit. The white clusters of single flowers are seen in October and November. Yields excellent timber. Wood very durable and used for flooring, cabinet work etc. Among the larger trees of Coonoor zone. Fine specimens at Sim's Park, Coonoor.

Propagated by seeds or cuttings.

150. **Taxodium distichum, Var. mucronatum,** Henry. Swamp or Bald Cypress. *Pinaceae.* Mexico.

A deciduous cypress with aerial projecting knee roots or 'cypress knees', forms a tall pyramidal specimen with fine leathery foilage which is bright yellow green. Flowers are in panicles; fruits borne in pairs. Wood soft and largely used for railway ties, fence posts etc.

151. **Ternstrœmia Japonica,** Thunb. *Ternstrœmiaceæ.* Himalayas and Japan.

A medium sized spreading tree. The leaves are crowded at the ends of branches, entire, gradually narrowing to the petioles. Inflorescence is axillary. Flowers pale yellow, seen during December–February. Fruits are produced during March–May. Propagated by seeds. A very ornamental tree. Wood also used as fuel.

152. **Thuja gigantea,** Nutt. Giant or Labb's Arbor-vitæ. *Pinaceae.* N. W. America.

Said to be by far the most handsome of the Thujas. In its suitable environment a beautiful, very tall, slender, pyramidal shaped tree with dark, glossy green, aromatic foliage, and fast growing. Branchlets slender

flexible and much compressed. However it is not very good at Coonoor, where the tree is about 20 feet tall, 12 feet broad, with trunk thickness of about 1 foot.

153. **Thuja japonica,** Maxim. Arbor-Vitæ. *Pinaceæ.* Japan.

An ornamental tree with flattened foliage. Grows to a height of about 30 feet. Cones are produced during November–January and are golden yellow and very attractive. Fit as solitary specimens in lawns and good for topiary work. The Thujas are propagated by seeds sown as soon as collected, also by layers, and cuttings of green shoots.

154. **Tristania conferta,** R. Br. Brisbane Box. *Myrtaceae.* Queensland.

A very handsome tree with smooth shiny pointed leaves suitable for higher elevations. Attains a good height of 120 feet, with smooth almost cylindrical straight stem, which is very much valued for its timber. Bark peels off in branches, exposing clean stem-wood. Flowers in axillary cymes appear during April to June. Fruits are like those of Eucalyptus. Easily propagated by seeds. Very ornamental and highly economic. Very good for avenues.

155. **Ulmus Campestris,** Linn. English Elm. *Ulmaceae.* Europe. West Australia.

A fairly large tree with often corky bark, of a most erect habit with spreading branches and ovate doubly serrate leaves. Flowers in spring time in clusters, white in colour. Fruits are winged. Timber is valuable for making planks, doors etc. Easily propagated by seeds. The doubly serrate leaves and white clusters of flowers add to the attraction of this tree.

156. **Vernonia monosis,** Benth. *Compositae.* Nilgiris.

The tree has a huge white cone of pappus and pale purple flowers, with the scent of heliotrope. Conspicuous in the Nilgiri sholas upto 7,000 feet. The tree is of about 63 to 70 feet in height, with trunk diameter of 2 to 2½ feet. It is one of the few trees in the natural order of compositae. Grows wild on the Nilgris. The head of white flowers during March to May adds to the attraction of the tree.

157. **Vitex littoralis,** A. Cunn. Australian Teak. *Verbenaceæ.* New Zealand.

An ornamental tree with its pink flowers and bunches of marble-sized rose red berries. The leaves are digitate. The inflorescence is in many flowered cymes appearing during December – January, and the fruit is a small round drupe, very attractively hanging in bunches during March—April. Propagated by seeds, suckers, layers or cuttings of green or ripened wood.

158. **Vitex pubescens.** *Verbenaceæ.* Nilgiris and Assam.

A large evergreen tree with very hard brown wood, and quadrangular branches. Underside of leaves and inflorescences is densly clothed with soft minute tawny pubescens. Leaflets usually three. Inflorescence dense,

and pyramidal with roundish top. Flowers during March - April, bluish purple in colour. An ornamental tree which also yields valuable timber. Propagated by seeds and suckers.

159. **Widdringtonia Whytei,** M. Wood. Mount M'lange Cedar. African Cypress. *Pinaceæ.* Central Africa.

This is a fairly big sized tree with the branches rising up in umbel shape, sparsely leaved towards the centre, base of the branches and trunk. Leaves are pale green, acute and distant on the branches. Cones are globular, and seeds are available from September to October.

A tree of considerable size, growing up to more than 100 feet. Considered ornamental on account of its cypress like branches. Good for 5,000 to 7,700 feet elevations.

19. NILGIRI FORESTS — THEIR PLANTS AND PRODUCTS

by T. ACHAYYA, B. SC. (Hons.), A. I. F. C.
Assistant Provincial Silviculturist,
Ootacamund

INTRODUCTION

The District of Nilgiris, with particularly its towns of Ootacamund and Coonoor, has been long a holiday and summer resort of people from the plains, not only because of its salubrious climate but also because of the scenic beauty that it offers. A major portion of the district forms the Nilgiri plateau about 35 miles long and 20 miles broad with an average elevation of 6,500 feet above sea level. The characteristic of this plateau is that it is formed by a long series of undulating hills with very fertile ups and downs that rarely rise very high above the general level. A range of hills runs through the centre of this plateau from north to south, dividing it into two almost equal halves which however vary in climatic conditions. This range culminates in the well known peak of Dodabetta (8,640 ft.) which is the second highest peak in the Western Ghats. This range of hills acts as a wind-break sheltering the two halves alternately from the two monsoons and thus providing them with widely differing seasons.

TYPES OF FOREST

The plateau is almost bare of any forests, in the real sense of the term, the original ones having been cleared by the earliest inhabitants like the *Badagas* and the nomadic *Todas*. That part of the land which has not been laid under the plough is covered with extensive grasslands (commonly called 'The Downs') interrupted here and there by small evergreen patches called 'sholas' which confine themselves usually to folds and nullahs. Actually, the only forests that cover the plateau are the extensive plantations of exotic species raised by both private individuals and the Government.

Since the district extends from 1,000 feet to over 8,000 feet, with a rainfall ranging from 30 to 300 inches and is subject to both the monsoons, it naturally shows a great variation of forest types which are of real interest. This change of rainfall, aspect, temperature and soil from place to place results in a corresponding difference in both general and specific flora which make the district highly representative of the flora of most South Indian forests and unusual in this respect. Small as the district is, it forms an ideal shady ground of forest types which are highly interesting to any student of botany.

Shola grassland type: The major portion of the district is covered with the shola-grassland vegetation, the grasslands occupying about 80 per cent of the area. These sholas consist of stunted, evergreen species which rarely reach a height of 20 feet. The percentage of shola to glasslands diminishes as we proceed from the eastern to the western half of the plateau. The principal species composing the shola belong to the families *Myrtaceae, Styracaceae* and *Lauraceae* with an undergrowth of Rubiaceous plants and *Strobilanthes.* The ground flora consist of ferns, mosses and occasionally reed-bamboos. A percentage enumeration carried out in one of the sholas on the Wenlock Downs gave the following results:

Litsea wightiana,	Lauraceæ	17·9	per cent
Rapania wightiana	Myrsinaceæ	14·5	,,
Meliosma wightii	Sabiaceæ	13 9	,,

The sholas though appearing to be alike in all respects, vary considerably in height, growth, and crop composition, depending on their situation. While certain species like *Symplocos spicata* and *Eugenia arnottiana* are found everywhere, others like *Hydnocarpus alpina* are found only on the Eastern plateau and *Eurya* only on the Western plateau. At lower elevations, these sholas show very much better height growth and gradually merge into the evergreen forests below. The sholas occur on a variety of soils and are exacting only in their requirements of soil moisture. They however avoid swamps and usually select sheltered places free from high winds.

The grasslands consist of a number of species of grasses growing in close association. They are capable of reaching

heights of two feet if protected, but rarely attain that height because of grazing and constant burning. These grasslands have been invaded to a very small extent by certain exotics, the most important of which are *Eupatorium glandulosum*, *Eulex europeus* (gorse) and *Cytisus scoparius* (broom). These seem to have been introduced into this district for ornamental and other purposes quite long ago.

The Downs which provide beautiful scenic grandeur are important not only because they form the catchment area of numerous small streams and rivers, the most important of which are the Bhavani and the Moyar (both of which are harnessed today), but also because they have been the subject of much controversy between different ecologists in regard to their formation. One school of ecologists is of opinion that the entire area must have been covered at one time by evergreen forests which have slowly receded because of the inroads of man who must have cleared them initially for cultivation and house-building, and later burnt them to get a fresh flush of grass for his cattle. This shifting cultivation must have resulted in the grasslands of today, the only vestiges of the old forests being the sholas in sheltered places, incapable of gaining ground again because of damage to natural regeneration by heavy frost (which is common on a major part of the Downs) and annual burning by Toda cowherds. The other school, however, considers the Downs a climatic climax, stable in the face of the fierce noon-day sun followed by an extremely cold night. Experiments conducted by the Silviculturist's Division of the Forest Department, wherein plant growth has been raised on the Downs by providing protection from fire, frost and grazing seem to lend support to the former theory but they have not been replicated enough to prove conclusive.

Exotic ptantations: Plantations raised on these grasslands consist essentially of large areas of pure *Eucalyptus globulus*, *Acacia decurrens* and *Acacia mollissima*. Occasionally a mixture of these two with eucalyptus in the top storey is also found.

Deciduous Monsoon forests: The lower slopes of the plateau where it adjoins Mysore are subject to the South West monsoon and are covered with monsoon forests of the

deciduous type. At higher elevations, these forests tend to become evergreen, while at lower elevations on the plains, they deteriorate into a thorny scrub. At their best they consist of a close canopied mixed deciduous forest of well known timber species like teak, *Terminalia tomentosa*, *Lagerstrœmia lanceolata*, *Dalbergia latifolia*, etc., attaining heights and girths making them useful as big timber. *Terminalia tomentosa* is the commonest and most widely distributed species while *Shorea talura* and bamboos are occasionally found. At some places where forest conservancy is good, teak occurs almost pure and shows good growth. In these areas, teak has been raised as plantation as early as 1864 but has never shown promise. The ground flora consists of tall grasses mostly belonging to *Cymbopogon* spp. and these are a cause of frequent forest fires.

In the lower scrub forests, the principal species are *Anogeissus latifolia*, *Albizzia amara*, *Santalum album* and Zizyphuses. An under-growth of lantana, grass and prickly-pear is most common.

Sandal forests: These scrub forests are the home of the valuable sandal tree which is found naturally scattered throughout the forest. Sandal forests are also found on the lower slopes abutting Coonoor. Very few plantations of the species have been raised.

Bamboo forests: Just below these sandal forests in Coonoor, the two common bamboos *Dendrocalamus strictus* and *Bambusa arundinacea* occur both pure and in mixture.

FOREST PRODUCTS

General: It is indeed surprising that a major portion of the forest produce of this District is the result of the introduction of exotics, originally done with no idea of such exploitation at all. A brief summary of the main marketable products, the method of exploitation, value and future possibilities will now be discussed.

1. *Timber:* The main timber species is teak of which about 33,000 c. ft. are felled annually. *Dalbergia latifolia* (rosewood), *Lagerstrœmia lanceolata* (venteak), and *Terminalia*

tomentosa (mathi) are the other timbers extracted from the mixed deciduous forests.

In the case of teak, exploitation is either done by clear-felling of the existing teak plantations or selection felling in the mixed deciduous areas. Both these operations are done departmentally and the converted logs dragged to roadside depots by means of departmental elephants. The timber is transported by contractors using motor lorries to the Government Timber Depot at Nanjanad, where it is sold in public auction.

In the case of pure teak plantations, the area is regenerated by stump planting of one year old teak stumps at spacing of 6 × 6 feet in crow-bar holes. The work is either done departmentally or by kumridars if available. The area of pure teak plantations is at present 586·21 acres and the area prescribed for annual clearfelling and regeneration comes to 20 acres.

In the case of mixed forests proposed to be converted into teak plantation, timber species of exploitable size are marked and extracted. The rest of the area is now clearfelled and burnt. The burnt stuff is spread evenly over the area and teak regeneration carried out as before.

In some of the other mixed deciduous forests, selection felling of valuable species is being adopted. The net area of the forests proposed to be worked by this method covers 28,226 acres. The species fit for exploitation are teak, rosewood, *Pterocarpus marsupium, Lagerstroemia lanceolata* and *Terminalia tomentosa.* In working these areas, production of revenue is not the main consideration, since this would mean removal of a number of trees and creation of large gaps. This would result in the creation of a dense undergrowth of grass and weeds which would invite fires into these already over-burnt areas. So marking for fellings is done with great caution, taking care to see that no large gaps are created. In case, advance growth is found on the area, this is felled or cut back where it is badly shaped, damaged or moribund. The marked trees are extracted in the case of teak using departmental elephants. The annual outturn of miscellaneous species comes to about 20,000 c. ft.

All the timber finds a sale in Mysore markets. The timber produced in this district is not good enough to compete with larger sizes on the West Coast and is hence never sent to Calicut and other West Coast markets.

The timber of bluegum, found largely on the plateau has been used sparingly during the last few years for house-building and other purposes. Some of the Australian species of Eucalyptus are noted for their timber value in their country but experiments carried out with them by the Silviculture Branch in Nilgiris have not proved very promising. Their rate of growth is found to be extremely slow, making them unfit for timber. The following hardwood species have been tried by the Forest Department:

1. Eucalyptus eugenoides
2. E. pilularis
3. E. propinqua
4. E. æmenoides
5. E. paniculata
6. E. crebra
7. E. punctata
8. E. hemiphloia

2. *Firewood:* The growth of the towns of Ootacamund, Coonoor and Wellington during the early part of the 19th century created a large demand for firewood. This was even more greatly felt because of the large scale destruction of the shola forests by the Badagas and Todas. *Eucalyptus globulus* and *Acacia dealbata*, two exotics, were introduced into the Nilgiris to provide cheap fuel to the residents of these towns and particularly to the army stationed at Wellington. The magnificent growth of the former made it invaluable for the purpose for which it was introduced, so much so that even to-day Nilgiris is the cheapest place for firewood in South India. The bluegum has so far not been attacked by any insects or fungus in the Nilgiris. The rate of growth is extremely fast and a 20–year rotation is followed. No thinnings are carried out. Standing coupes are sold to contractors who fell the trees using saws, cut them into 3 ft. billets and stack them into fuel lots of 8 ft. × 5 ft. × 3 ft. A lot of fuel at site fetches from Rs. 15/- to Rs. 18/-. Regeneration of felled coupes is by simple coppice,

each stool giving an abundance of coppice shoots. Finally about 2 or 3 shoots survive and come out for felling. After 3 coppice rotations, the area is again planted up. Normally one acre yields from 30 to 60 lots (120 C. ft. each).

The production of Acacia fuel will be dealt with under wattle bark.

3. *Eucalyptus Oil:* Not only is *Eucalyptus globulus* (popularly called the bluegum) useful for the cheap fuel it gives, but it yields another product, eucalyptus oil, which has made Nilgiris famous throughout the world. In the Government plantations, one year prior to the felling of the trees, the leaves are sold in public auction. These are lopped by the contractor and oil obtained from them by a process of simple distillation carried out in crude stills which are carried from place to place. About 400 lb. of leaves yield 4 to 5 pounds of oil which sells at Rs. 4/- to Rs. 5/- a pound. Bombay is the biggest export market. In Nilgiris, about 30,000 pounds of oil are produced annually in both the private and Government plantations.

The total area under bluegum in the custody of the Forest Department is 1,776 acres. The area under private management is about 2,400 acres. The annual area regenerated by the Forest Department is 60 acres. The average cost of formation comes to about Rs. 60/-. The average price obtained per acre is about Rs. 600/- for fuel and Rs. 200/- for leaves. A net profit of Rs. 700/- per acre is therefore now obtained in 20 years. During the recent visit of the Inspector General of Forests of the Government of India to the Nilgiris, he suggested that instead of lopping each plantation just once during a rotation, it could be done with no harm to the trees atleast three or four times. This rotational lopping scheme would certainly increase revenue and will be put into practice soon in the Nilgiris.

It will thus be seen that the bluegum so commonly seen has proved a God-send to this District.

4. *Wattle: Acacia dealbata* (silver wattle) was introduced into the Nilgiris about the same time as 'bluegum' for fuel purpose. It however did not prove to be such a striking success, since the growth was not so good and the

fuel burnt with an unpleasant odour. This species propagates easily by root-suckers and has now run wild over large areas. About the middle of the last century, two other species *Acacia decurrens* (green wattle) and *Acacia mollissima* (black wattle) were introduced and have now completely replaced the silver wattle.

The leather industry in this country has been one of great importance for the past two centuries. Tanning of leather is the most important process in the manufacture of usable leather and for this a tanning material is essential. Of all the tanning materials now in use, wattle bark takes first place because it contains the highest percentage of tannin (35–40) and is available in large quantities. Till the cessation of trade relations with South Africa in 1947–48, all the wattle bark required in this country came from there but with stoppage of imports, the demand for home-grown wattles grew apace. Our annual requirements are from 1 to 1½ lakh tons and with the sudden jump in prices from about Rs. 120/- per ton to about Rs. 700/- per ton, this product is a real money-earner for the State.

Though *Acacia decurrens* is faster growing, its place is rapidly being taken by *Acacia mollissima*, since the bark of the former tends to impart a colour to the leather.

The species grow well from 5,000 to 7,000 feet on a loose, well drained soil and are frost tender when young. They thrive in damp misty weather with a well distributed rainfall of about 55 inches.

The high demand for wattle bark has led the Government to encourage its being grown by sanctioning a large scale scheme of raising 6,000 acres on a 10 year rotation at the rate of 600 acres per year. The area selected is the extensive grasslands around Mukurti and a beginning has been made in 1950.

Financially the growing of wattle is a worthwhile proposition. Formation costs come to about Rs. 40/- an acre and exploitation costs of bark about Rs. 350/- per acre. Thus the total expenditure per acre comes to about Rs. 390/-. An outturn of 5 tons of bark valued at Rs. 700/- (at pre-war rates) and 25 tons of firewood valued at Rs. 250/- can be

easily obtained per acre. So the net again per acre comes to Rs. 560/-.

These are not the only possibilities with the species. The timber is found to be good for the making of mechanical paper pulp and has been used by some countries for cheap paper and straw-boards. In the Nilgiris, with good water supply and cheap Pykara power, the possibilities of starting a paper mill are indeed great.

During the recent visit of the Inspector General of Forests to the Nilgiris, he made a number of valuable suggestions for improvement of wattle cultivation. He has suggested the provision of Eucalyptus wind-breaks and the planting of bluegum as a frost cover about 40 ft. apart. Moreover, seeing the vigorous growth of wattle on abandoned potato fields, he feels that wattle can be raised for no cost at all in conjunction with one or two crops of potatos, which would also go a long way to ease our food position.

5. *Pyrethrum:* Another exotic that came into prominence in the Nilgiris was pyrethrum. This most important plant insecticide was first discovered in Persia and subsequently introduced to Europe by an Armenian merchant early in the 19th century. His son commenced manufacture of the powder in Dalmatia in 1828 from an improved strain of the species. The discovery of the toxic properties of pyrethrum was accidental. A German lady in Dalmatia collected a boquet of these flowers which she threw away when they had withered. A few days later, she found to her amazement that the boquet was surrounded by a heap of dead insects. Until 1918, only the powder form was in use but in that year house-hold sprays appeared and pyrethrum entered a new era of usefulness for horticultural and other sprays.

The principal insecticidal constituents are pyrethrins found in all parts of the plants but particularly in the flower heads. It has the great advantage of being completely non-toxic to warm-blooded creatures, making it absolutely safe when added to any foods destined for human or animal consumption. Moreover, till to-day it has not been synthesized by any manufacturers.

Largely due to World War I, Japan entered the field of production and held the world monopoly of the trade. The beginning of World War II found the Allies in a difficult position for the product, which they needed in large quantities to keep their soldiers free from bugs, ticks and other insects. Kenya which started production in 1935 soon held the world monopoly and it was from this country that pyrethrum was introduced into India in 1942 – '43.

Though the pyrethrin content of Nilgiri flowers comes to 2·1 per cent which is the highest in the world, the yield per acre is extremely low. We have still to do a great deal of research before we can come up to world standard, in the status of yield.

6. *Bamboos:* No regulated working of bamboos is carried out in this Division and extraction is done by permit-holders who apply for them as and when necessary.

7. *Tung-Oil:* The two species *Aleurites montana* and *Aleurites fordii* commonly called the 'tung-oil' trees have assumed great importance during the past few years. Belonging to China, their seed is found to give a quick drying oil, useful for high class painting work like motor car painting etc. where a quick dry is essential. A few trees have been tried out with success by the Silviculture branch and recently, the Government of India deputed its Tung-Oil Expert to select suitable areas in the Nilgiris and other places in South India for large scale planting. These areas have been tentatively selected and will be taken up in due course. Tung oil tree appears to have a great future here.

8. *Lac: Schleichera trijuga,* a good host plant for the lac insect, *Laccifer lac,* which produces an exudation of great use in the manufacture of furniture polishes, sealing wax, shellac and a host of other products is found in quite large numbers in the mixed deciduous forests adjoining the Mysore plateau. Though systematic lac cultivation was tried in the past, the success obtained was not encouraging enough to continue the work. Now with the high prices obtained for lac and the ready demand for the product by the Lac Factory at Denkanikotta in Salem District, run by the Forest Department, it is contemplated to restart regular operations.

9. *Minor Forest Products:* The principal items collected mostly from the mixed deciduous forests are honey, wax, gall-nuts, shekoy, Avaram bark (*Cassia auriculata*) for tanning, Konnai bark, (*Cassia fistula*) Myrobolans fruit (*Terminalia chebula*), tamarind, soapnut, ginger, canes and nux-vomica. Honey, wax, gall-nuts, horns, shekoy and Elephant tusks (not strictly a forest product) are generally collected departmentally, while tan barks, canes, etc. are collected by contractors. Lemon grass is also found in large quantities and can easily be distilled at great profit.

In the plateau, *Gaultheria fragrantissima* (source of wintergreen oil) and Salamisri (*Orchis* spp.) are frequently found but are not exploited.

10. *Sandal:* The mixed deciduous forests on the Mysore and Coonoor sides abound in sandal (*Santalam album*) in the drier parts. Here also as in the rest of the State, the sandal is subject to large scale attack by that well known disease 'Spike', the cause and prevention of which is still a mystery, in spite of large scale research for the past so many years. At present, exploitation is limited to uprootal of dead trees, natural regeneration being depended upon to restock the area. A felling cycle of 3 years is adopted and each felling series divided into three annual coupes. All dead trees over 3 inches in girth are marked, numbered and extracted with the roots. The root portion is found to be the most valuable and fetches the best prices. The extracted tree is cut into smaller sizes and each separately numbered. The tree can easily be re-formed for purposes of check. The sandal is now rough cleaned by removing all the sap wood except for a thin layer after which it is sent to the sale depot at Satyamangalam in Coimbatore District. The Nilgiri produces about 30 tons of wood annually which at the current rate of about Rs. 4,000/- a ton means a revenue of Rs. 1,20,000.

Thus it will be seen that the Nilgiris though the smallest district in the State presents an extreme variety of flora both indigenous and exotic and contains a number of marketable products, some of which have made her famous in the world.

20. MISCELLANEOUS ECONOMIC PLANTS IN THE NILGIRIS

FODDER AND PASTURE PLANTS

The problem of fodder for their cattle on the Nilgiris is met by the agricultural communities of the district mostly by the grazing of the animals in outdoor pastures. A part of the fodder needs of the cattle is also met by such straw as that of samai (*Panicum miliare*), barley (*Hordeum sativum*) etc. During the winter months and when in higher elevations such as Ootacamund, often frost is severe and the pastures are "burnt", and when the cattle have very little scope for outdoor grazing, the problem of fodder supply is acute. On these occasions, the agricultural community falls back upon its stock of straw, and to supplement it with green feed, the leaves and tender branches of some of the trees growing within the open spaces and forests such as *Acacia melanoxylon*, *Ilex wightiana* etc., are utilised. Worthy of attention in this connection as tree fodders are such trees as the carob *(ceratonia Siliqua)*, the honey locust *(Gleditsia triacanthos)* and the mesquite *(Prosopis juliflora)* etc. which should be tried on the slopes of the Nilgiris. The tree lucerne *(Cytisus proliferus)*, Garcia *(C. stenopetalus)* and Garcia Blanca *(C. pallidus)* may also be attempted as stand-by for fodder purposes in their suitable zones.

Kikuyu

Of all the grasses in the pastures of higher elevations of the Nilgiris, the grass which has spread quickly and widely during the last two decades is the *Kikuyu* grass, *Pennisetum clandestinum*, Hochst, a native of East Africa. It grows very rapidly and well on almost all kinds of soils in the Nilgiris and is very drought resistant. It is a creeping perennial, forming a dense short sod and when there are good rains, it reaches a height of 2 to 3 feet. It is considered an excellent grazing grass and suffers no ill-effect from close grazing or trampling by cattle. The composition of this grass as analysed by the Government Agricultural Chemist, Coimbatore is noted below:—

Moisture	8·09	per cent
Ash	14·83	,,
Protein	9·99	,,
Fat	1·46	,,
Fibre	21·95	,,
Carbohydrates	43·68	,,

The original plant material of kikuyu is recorded to have been introduced first into Coimbatore in about 1924-25 and tried both at the Central Farm, and the Millets' Station, Agricultural College, Coimbatore. It was subsequently introduced into Nanjanad Agricultural Research Station on the Nilgiris, where it proved to be a fine success as a fodder plant giving as much as 30,000 lb. of green grass per acre.

Besides this, as a soil binding grass, it has few equals. But when it is grown near cultivated fields, due to its rapidity of growth, it soon begins to dominate the neighbouring fields. Because also of its "sod-bound" nature, it is difficult to eradicate it from any field where it has taken a foot-hold. In this respect it becomes a troublesome weed. But its

great pasture value on the hills is unquestioned. Moreover because of its soil-binding nature, it is a good grass to grow on the sloping forest lands subject to erosion.

Other Pasture grasses

Where kikuyu has not penetrated, the pastures on the Nilgiris are a mixture of several grasses and a random sample of pasture examined by the author at Ootacamund revealed that the following eight grasses were rather dominant in the mixture :—

1. *Amphilophis insculpata*, Stapf.
2. *Anthoxanthum odoratum*, L.
3. *Bromus catharticus*, Vahl.
4. *Eragrostis nigra*, Nees.
5. *Eragrostis tenuifolia*, Hachel.
6. *Panicum repens*, L.
7. *Paspalum dilatatum*, Poir.
8. *Poa annua*, L.

Fodder plants

As regular fodder plants for cultivation, the Madras Agricultural Department introduced on the Nilgiris the Napier grass *(Pennisetum purpureum)*, Buffalo grass *(Buchlœ dactyloides)*, and Guinea grass *(Panicum maximum)*. Napier grass is a native of tropical Africa and a perennial reed like grass, growing upto a height of 6 to 8 feet, and yielding good tonnage, useful in parts of Nilgiris where frost is not frequent. The Buffalo grass is a low stoloniferous perennial, and forms a most important and valuable part of the natural pasturage in the United States of America. It forms a dense and firm sod covering the ground entirely. The Guinea grass is also a native of Africa, and one of the best perennial forage grasses in the tropics, giving a large tonnage of fodder, standing frequent cuttings. Expansion of these grasses on the Nilgiris requires further investigations. In some of the tea areas, the Guinea grass and Napier grass are reported to be thriving well. To ensure good success with fodder growing on the Nilgiris, proper fencing against cattle trespass is quite essential.

Berseem or Egyptian clover *(Trifloum alexandrinum)* and lucerne *(Medicago sativa)*, were also attempted on the higher elevations of Nilgiris. In 1939 - 41, trials were made with berseem at the Agricultural Research Station at Nanjanad and it gave 6,700 lb. per acre in 1939 - 40 and 4,500 lb. per acre in 1940 - 41 and subsequently proved a failure. Lucerne was observed to fare worse than berseem and no proper stand of crop even was obtained. Subterranean clover *(Trifolium subterraneum)* introduced in 1938 proved a good success at the Government Botanic Gardens, Ootacamund and was found resistant to frost. Lupins which are dealt with under green manures are also useful as fodder.

There is need for systematic introductions and investigations with new fodder plants on the Nilgiris. The U. S. A. with its varied climates and with advanced work with numerous grasses offers a good field for introduction to Nilgiris.

GREEN MANURE PLANTS

In the general agriculture of the Nilgiris, the use of green manures is not much in evidence. The crop rotation for several years has centred

around the potato as the main crop, and the farmers are generally unwilling to forego the residual effects of the heavy manuring of the potato crop on a green manure crop to follow, and would rather have a cash or grain yielding crop in preference. The Agricultural Research Station, Nanjanad however has for many years been experimenting with raising of green manures, and this station has found lupin among the best green manure crops for the higher elevations of the Nilgiris. Three different species of lupin are useful viz., *Lupinus lutens*, (blue lupin), *L. angustifolius* (sweet lupin), and *L. Termis*. Seeds of sweet lupin can also be fed to cattle. Lupins in general are not only restorative plants as green manure but are also highly valued as fodder.

For the lower elevations, 3,000 feet and below, the Kallar and Burliar Fruit Stations have been attempting a number of green manure plants among which preliminary reports on the following have been favourable.

1. *Glyricidia maculata.*
2. *Tephrosia vogelii.*
3. *Calopognium mucunoides (a creeper).*
4. *Centrosema pubescens (a creeper).*
5. *Pueraria javanica.*
6. *Crotalaria anagyriodes.*
7. *Crotalaria striata.*
8. *Leucœna glauca.*
9. *Indigofera teysmanii.*

In the tea plantations of the Nilgiris, the most common species which serve as green manures are *Tephrosia candida*, and *T. vogelii*, *Crotalaria anagyroides* and *C. striata* and other species of Crotalaria. In these tea plantations, the leaves of dadap *(Erythrina lithosperma)*, are also used for green leaf manure.

The buckwheat *(Fagopyrus esculentum)* which grows very well and rapidly on the higher elevations yields upto 15,000 lb. of green matter within about 2 to 2½ months and has a reputation as a good green manure crop and is easily decomposed. It is worthy of wider attention.

BEVERAGE AND MASTICATORY PLANTS

The main beverage plants of the Nilgiris are tea and coffee, and separate articles have been written on these (See "Tea on the Nilgiris" and "Coffee Industry in Nilgiris") and hence they will not be dealt with here.

The other beverage plants are those still under trial, viz., cacao *(Theobroma cacao)*, cola nut *(Cola acuminata)* and Mate *(Ilex paraguensis)*.

Cacao

The term "Cacao" is generally used for the crop and 'Cocoa' for the manufactured product, but both the words are usually pronounced alike. Cacaos have two types, (1) *Criollo* with white beans and (2) *Forastero* with violet beans. Commercially, cacaos are now practically all Forastero, but some have Criollo admixture in their ancestry. The Forasteros are more hardy and more productive than Criollo. Cacao plant is of South American origin, but over half of the worlds' production of cacao comes from West Africa, particularly Gold Coast.

Criollo has two sub-types, (1) Central American Criollos and (2) South American Criollos, and Forastero has also two sub-types (1) Amazonian

Forasteros, cultivated in West Africa and Brazil and (2) Trinitarios, of hybrid origin, cultivated in Trindad, Ceylon and Java etc. West African and Brazilan cacaos are commercially classified "Ordinary" and the Venezuela, Ecuador, Trindad and Ceylon as "Fine" cacao.

Cacao seems to have been introduced into Kallar about 30 years ago, and it is only in recent years that its potentiality for further cultivation and expansion on the Nilgiris and similar hill zones in South India has been realised. Messrs. Cadbury Brothers, Ltd., London, whose chief chemist examined the cocao obtained from the Kallar Criollo cacao variety highly commended the quality of the cacao as equal to any Criollo cacao and also the beautiful cinnamon colour obtained after fermentation. Kallar has at present a few bearing trees of only the Criollo variety, and considering the cross pollinating nature of cacao, this station on the Nilgiris can form easily the nucleus for expansion of a pure variety of cacao on the Nilgiris and elsewhere. The Kallar zone in addition seems to be congenial to cacao, as so far no serious insect pests and diseases have been noticeable.

The cacao plant is a small spreading tree capable of a height of 20 to 30 feet. Its habit of growth is both peculiar and important. The main axis terminates in 3 to 5 spreading branches, the *jorquette*, from below and through which a vigorous water shoot in turn produces a similar whorl of branches so that a typical cacao tree consists of a series of storeys superimposed one over the other. The inflorescence is a much condensed dichasial cyme appearing as clusters borne on cushions situated on the trunk and branches. The flowers contain 5 stamens, each bearing 4 anthers and alternating with an equal number of staminodes, and recurved, with anthers lying in the cup-shaped bases of the petals. The fruit is a large berry containing numerous exalbuminous seeds imbedded in a mucilaginous pulp.

The following important points and broad principles in the cultivation and processing of cacao are given as aid to potential growers:—

Climatic requirements: Cacao requires a warm moist climate, with a low altitude of 1,000 to 2,500 feet, with temperature range being 80° to 100° F. for the maximum and 45° to 60° F. for the minimum, and a well distributed annual rain-fall of 60 to 80 inches. It does not endure frost or drought.

Propagation: This is by seed. Fully ripe seeds are washed free of any pulp before sowing. The Kallar Fruit Station has reported 50 to 60 per cent success in layering and 60 to 80 per cent in patch budding done in June to August.

Seeds are sown in situ or seedlings raised in plant baskets preferably, and transplanted when about a foot high.

Spacing: 12 to 15 feet spacing may be given between trees either way.

Shade: Except in Grenada, everywhere cacao is grown under shade. Successful permanent shade trees for the plantations in other countries have been such as *Erythrina* or *Pithecolobium* spp. In some countries cacao is interplanted with nutmegs. Soon after planting of seedlings, pandals may be erected with bamboos to provide immediate direct shade. Secondary shade may be provided with bananas or glyricidia, just as attempted in their recent trials in the Kallar Fruit Station.

Training and pruning: Pruning in cacao is done in commercial growing countries to ensure that the tree starts with one main stem only, and further suckers are removed from the main stem after the main laterals are formed.

Cultural operations: Constant mulching around plant basins with leaves or trash to a depth of about 6 to 9 inches, about 6 inches away from the plants is important. The ground may be lightly forked once a year.

Fruiting and harvesting: In such countries as Trinidad, it is reported that the cacao trees come into bearing between 8 and 11 years after planting, attaining peak yields in 15 to 25 years, declining in yields upto 45 years, remaining steady thereon and fruiting till 80 to 100 years. It is reported that at Kallar Fruit Station, the trees come to bearing from 3rd year onwards but fuller investigations on the commercial aspects of growing cacao at Kallar are yet to be investigated.

Fruiting is observed at Kallar almost throughout the year with peak harvests in April–May and December–January.

Only ripe and fully coloured pods are harvested with a knife, a hooked knife on a pole being used to reach the high ones on the trees. Care should be taken to cut the stalk of the pod a little away from the cushions, which bear the crops.

Processing: The harvested pods are piled in a heap and left for 3 to 4 days to facilitate the easier removal of the beans. The pods are then cut open and the beans are removed by hand for fermentation. The African farmer in the Gold Coast accomplishes fermentation by piling the beans in large heaps, covering with banana leaves and leaving them thus for 4 to 6 days, with occasional turning. The aim of fermentation is to get rid of the pulp, to remove the bitter taste from the beans and to help develop the characteristic chemical compounds including theobromine which gives cocoa its stimulating property. The methods of fermentation described above are a comparatively crude method, but a better method adopted in well organised estates is to carry on the fermentation in wooden boxes in a fermenting house, in a more systematic manner. It must be mentioned here that the chemical changes which accompany the fermentative process are not fully understood, but they largely influence quality. Direct fermentative action appears to be limited to the pulp, but the heat developed in the process is enough to kill the embryo permitting diffusion of, and interaction between, the cellular contents. To a very large extent, therefore, the quality of cocoa is a controllable factor and the fuller standardised processes of fermentation under more controlled conditions yield better quality of cocoa. After fermentation, the beans are sundried, preferably on drying trays, and bagged for sale and export.

These beans are later cleaned, roasted and shelled, and this resulting product is called *Cocoa nib*. This cocoa nib is crushed and mixed together with sugar to form the *drinking chocolate* sold as flakes or powder. In the process of manufacture of cocoa powder, the excess fat known as *cocoa butter* is expressed. The cocoa butter added in proper proportion to cocoa powder with sugar forms the *chocolate*. Cocoa butter is also used in confectionery, margarine making and perfumery. Cocoa has also good quantities of vitamins A and E.

The shell of pods is reported to be useful as cattle feed and is rich in potash also. Theobromine, used as a heart tonic, is also prepared from the shell of the beans.

The world supplies of cocoa are reported to be far short of demand and its expansion and encouragement in suitable zones of India will be worth active consideration.

Cola nut

This is a native of West Tropical Africa, where it is also economically important, particularly in the Gold Coast. The nuts (seeds) contain 2 per cent of caffeine *(kolatine)* and are exported to Europe and other countries, where they are used in several preparations such as kola wine, kola chocolate, and in medicine etc. Throughout Central and North Central Africa, the nuts are popular as a masticatory and are supposed to be good stimulants. This tree is suited to low elevations upto 2,000 feet and has been under trial at Kallar and Burliar group of Fruit Stations.

Mate

It is also known as *Yerba de mate* and "Paraguay tea". This is a favourite beverage of South American countries and mainly produced in Brazil and Paraguay. The leaves are used in the same way as tea. It is said to require similar climate and soil conditions as tea and has possibilities on the Nilgiris.

Arecanut. *Areca Catechu,* L.

Since the Kallar zone has been included for its economic plants, it is only proper that arecanut growing in this zone should not be ignored and hence a brief account is given here. Large plantations of arecanut are just adjacent to the Kallar Fruit Station and a number of trees are also grown in the Kallar Fruit Station. Arecanut is one of the chief commercial crops in this zone and the processing and marketing are all done in the nearby commercial town of Mettupalayam. The total area of arecanut in the Coimbatore district is said to be around 1,500 acres of which 1,100 acres are in Kallar area, where it is mostly grown on the main banks of Coonoor and Kallar rivers, as this tree requires plenty of water and thrives on the soils here with deposits of silt brought down by the rivers. Red loamy soils are quite suitable for arecanut.

For propagation, seeds are gathered from fully matured nuts from high yielding, 40 to 50 year old trees. Seeds are sown in nursery beds 3 to 4 inches apart, and they are pricked out when about a year old and planted in nursery beds with wider spacing. After a year again, the seedlings are transplanted in the main field, at distances varying from 5 by 5 feet to 8 by 8 ft. An acre contains on an average about 1,200 trees. Regular manuring is not common. Watering is done from channels by gravitational flow, once in 10 or 15 days. The soil is disturbed and weeded by the mammoty about twice a year. In about 8 years from planting, the trees begin to flower. Usually the flowering is from December–January to April–May. Bunches can be harvested from June onwards till December. On an average about three or four bunches of nuts are obtained from each tree, a bunch containing about 150 nuts. The yield per acre is about 70 to 100 bags of 3,500 nuts each.

The method of harvesting is characteristic of the arecanut. The bunches are harvested by a sharp curved sickle at the end of a long bamboo held by a man who climbs up a tree and cuts the bunches of the neighbouring tree. He transfers himself from one tree to the other, while on the tree, by drawing the neighbouring tree close to him with the bamboo pole in his hand. A man who gets up the trees in the morning, climbs down only for the lunch interval.

Harvest of the bunches is done when the nuts are small and tender. The nuts are separated from the bunches by beating the bunches on the

ground. The nuts are cleaned of foreign matter with a sieve made of bamboo splices. The green nuts are husked the same day or the next day. If this operation is delayed by more than two days, the quality of the nut is *said to deteriorate*. The nuts are cut into two halves transversely. While cutting, hard nuts are sorted as "*Kottaipakku*", which could be sliced into 2 or 3 bits. The tender nuts are cut into two halves and these are known as "*Kallipakku*". The end bits of "*Kottaipakku*" are cut into angular shapes and graded into "*Thappakurunai*". There are local experts who do the processing and grading. The sliced nuts are boiled, drained, coloured if necessary and dried until they are free of moisture. The colouring matter is provided by the solution obtained while the nuts were boiled previously after concentrating this very much. An average of 800 lb. of cured nuts is obtained per acre. Merchants from Satyamangalam, Puliampatti etc., and neighbouring places purchase the materials from the producers at the market rates prevailing at the time. The nuts from this area meet only the demands of the district.

FRUITS

The fruits in the Nilgiris have been dealt with separately in the article "Fruits of the Nilgiri Hills" and "Citrus in the Nilgiris with Particular Reference to Kukal oranges". Apart from what has been dealt with in those articles, there are a number of fruits on the Nilgiris whose cultivation does not differ from that on the plains and are restricted to the lower elevations, mostly below 2,500 feet. Among these are the banana, the sapota, the pineapple, the papaya and the mango. Kallar Burliar group of Fruit Stations grow one or the other of these. Among bananas, Laden and Dorai Valai are seen to grow well in this zone under rain fed conditions more or less. Besides this, the Kallar Fruit Station has been maintaining a comprehensive collection of banana varieties and attempting some breeding work. The Pala variety in sapotas has been faring well in this zone. The Kallar Fruit Station has been growing pineapples and experimenting with plant hormones to regulate fruiting. Kew and Mauritius are among the pineapple varieties tried at Kallar. Some general work in papayas has been also in progress in the Kallar-Burliar Fruit Stations. The Peter and Khudadad varieties of mango have been doing fairly well at Kallar. Cashew-nut trees are also being tried at Kallar Fruit Station.

Specimens of the following trees may also be found in the Kallar-Burliar group of Fruit Stations:

Spondias mangifera. Hog Plum. This produces round or ovoid fruits of the size of a small mango with a large seed surrounded by coarse fibre and scanty acid pulp, which makes good preserve. It is propagated by seed.

Engenia malaccensis. Malayan Apple. This is an ornamental fruit tree capable of big size, producing oval fruits, 2 to 3 inches long, whitish in colour with crimson patches all over the surface, thin skin, crispy and juicy flesh with a good subacid flavour. It can be propagated by seed or by inarching on itself or on roseapple.

Macadamia ternifolia. Queensland Nut. It is a nut tree producing small, oval shaped fruit, with a small beak, greenish in colour, containing hard seed which has whitish kernel of fine flavour and taste. The specimen in Kallar was planted in 1921.

Chrysobalanus icaco. Coco Plum. Spanish Nectarine. This is a small tree. The reddish purple, plum-like fruit, having a large kernel surrounded by white soft sweetish but scanty pulp can make fair preserve but not a quality dessert fruit.

Muntingia Calabura. Calabura. This is a small or medium sized tree whose small yellow-berries make good jam or tarts. Leaves are said to be used similar to tea, in some South American countries.

The Coonoor Pomological Station and some private orchards in higher elevation have specimens of following trees :

Morus nigra, L. Black Mulberry. It is a medium or small sized tree under Coonoor conditions. It produces roundish fruits, like that of a bramble, nearly black when ripe. The fruits of the trees at Coonoor are of inferior quality.

Juglans regia. Walnut. It is a deciduous nut tree. The performance at Coonoor has been very poor, with unduly prolonged pre-bearing stage.

Eriobotrya japonica. Loquat. Japanese Medlar. This is a small or medium sized ever green fruit tree, producing spherical to pyriform fruit, pale yellow to deep orange red in colour, juicy and tasty in good varieties. The trees on the Nilgiris are generally of inferior variety. Specimens of these trees can be seen here and there on the Nilgiris, particularly the higher elevations.

The pomegranate is seen to be growing on the Nilgiris upto elevations of nearly 6,000 feet, but the varieties available are inferior in quality. Specimens of a good hedge of pomegranate can be seen at Pomological Station, Coonoor. Grapevine has not made any headway on the Nilgiris, and has not received very systematic attention and is worth further investigations.

OIL SEEDS

The oil-seeds worthy of some mention are only the oil-seeds of the plains grown in lower elevations of the Nilgiris in very small areas. The Government statistics for Nilgiris for 1949-50 reveal that in that year, gingelly occupied 25 acres, groundnut 38 acres, castor 3 acres and coconut 2 acres.

In recent years, some interest has been shown in introduction of tung oil into Nilgiris. The tung oil, if it can be produced in India on a large scale successfully, will be one of the valuable industrial oils, needed by the country. The oil is much in use in China and Japan as an illuminant; for preserving and water proofing wood-work, cloth and the like; in paints, soaps, and linoleum; in varnish industry, caulking and painting of junks and boats, varnishing furniture, lacquer work, and also in medicine; and as such is an article of enormous consumption by particularly the Chinese. The Americans have rapidly expanded their tung oil plantations and they use tung oil as a valuable drying oil for use in paints and varnishes. The oil is similar to linseed oil, but dries quicker, harder and is more water proof, but less light-proof and elastic. Though there are five useful species of tung tree viz., (I) *Aleurites Fordii* (2) *A. montana*, (3) *A. moluccana*, (4) *A. cordata* and (5) *A. trisperma*, *A. Fordii* has been the species which has come into prominence in U.S.A. As early as 1929-30, the Curator, Government Botanic Gardens, Ootacamund, obtained 4 ounces of seeds from the Silviculturist, Forest Research Institute, Dehra Dun, from which 66 seedlings were raised and distributed

in 1929–30 to the Pomological Station (Coonoor), Sim's Park (Coonoor), and Fruit Stations of Burliar and Kallar. Earlier in 1928–29, seeds had been obtained from the Rayal Botanic Gardens, Kew (England) and these failed to germinate. In none of these places did the trees seem to have faired satisfactorily. The one tree that is surviving in Sim's Park, Coonoor, had attained in 1951, after nearly 21 years, a height of 15 feet, a spread of 12 feet on either side, and a stem girth of about a foot. The tree is also seen to be very shy-bearing.

However, more systematic trials in different zones of the Nilgiris require to be attempted before any conclusion can be drawn regarding the suitability of the Nilgiris for tung oil tree. In recent years, with the interest of the Central Government in the tung tree, the Silviculturist, Ootacamand in co-operation with officers of the Agricultural Department on the Nilgiris, and with encouragement of the Central Government has resumed wider trials with this valuable tree.

The Kallar–Burliar Fruit Stations have specimen trees of the following oil yielding trees :—

Elæis guineenis. Oil Palm. This is a tree, native of W. Tropical Africa, capable of growing in suitable localities upto 60–70 feet height, the nuts yielding valuable vegetable oil. The palm furnishes also edible fruit used like coconut in many ways and palm toddy, an intoxicating drink. The leaf stalks and leaves are also used for thatching houses.

Butyrosperumum Parkii. Butter Tree. It is a medium sized or large tree with a stout trunk. The fruit has a large fleshy nut (seed) inside, from which can be obtained a large percentage of stearine fat useful for cooking.

INSECTICIDAL PLANTS

Derris. *Derris elliptica.*

The plants of derris are climbing shrubs with a short trunk 3 or 4 feet in height and 4 inches in diameter with numerous branches which climb over. The dust made from the ground roots of this plant has marked insecticidal properties. The active ingredients of derris roots include a rosin and a rotenone, a white crystalline substance. The rotenone in the roots is about 4 per cent, and sometimes goes upto 8 per cent.

Derris has been grown for some years in Kallar with fair success. It grows well in fertile soils at low altitudes with warm moist tropical climate. It can be propagated by stem cuttings. A spacing of 3 by 3 feet is suitable for derris. The roots can be harvested about 1½ to 2 years after planting. To harvest, the stems are cut to the base and the roots lifted in a clump with a fork. The roots are cleaned well, avoiding water, and cut into bits of one foot length and dried for 10 to 15 days in the shade, till they come to a stage when they break when bent. They are then collected into bundles and preserved for use as insecticidal dust or spray.

For preparing dust, the dried roots are finely pulverised and mixed with inert material like wood ash 1 : 6 by weight. The dusts are highly effective against caterpillars and lice on foliage.

For preparing spray, the derris roots are mashed to pulp in water, and spray prepared containing 1 lb. of derris roots in 15 to 20 gallons of water and 2 lb. of soap added as spreader. The spray is also effective against caterpillars, plant lice and thrips.

This insecticide provides one of the most practical methods of control of cattle grubs. In concentrations used in insecticides, it is not toxic to animals and human beings.

Tephrosia vogelii

This species yields an effective insecticide. An infusion of its leaves in combination with soap is as effective an insecticide as nicotine sulphate, and the efficacy of this as an insecticide has also been demonstrated by tests of the Government Entomologist, Coimbatore. The seeds of the plant are also reported to be very toxic and an infusion prepared with seeds is also said to be effective against mealy bugs. In 1939, seeds were obtained from the Superintendent of Plantations, Tanganyika territory and were tried at Coonoor and Kallar, where they established fairly well.

Millettia Pachycarpa

This is a creeper, yielding retenone from its roots and has been under trial at the Kallar Fruit Station.

Pyrethrum has been dealt with separately in another article and hence is not treated here.

RUBBER PLANTS

The Nilgiri District has a history of experimentation with rubber. The first rubber trees planted in South India are said to have been Ceara plants, *(Manihot glaziovii)* obtained from Kew at the teak plantations at Nilambur in Malabar in October 1878. Some Para plants *(Havea brasiliensis)* were received at the same plantations in June 1879 from the Botanic Gardens, Ceylon. In the same year, at these plantations, Panama rubber plants *(Castilloa elastica)* were also received. In 1881, Para and Castilloa trees were planted at the Government Gardens at Burliar. Even today some well grown Para trees can be seen standing in the Kallar–Burilar group of Fruit Stations in the Nilgiris. In the subsequent years, some of the planters in Wynad side and in Kotagiri in the Nilgiri District tried Ceara rubber either in small plots or as shade among coffee. It was discovered soon however that Para trees actually killed the coffee growing under it and that their yield was also variable and uncertain. Added to this at this period, there was the gold mining boom which did not permit attention to such experimentations. About 1902 however, the interest in rubber revived on the Nilgiris, and Mr. A. C. Nicholson planted some more Para and Panama rubber on his Glenburn property below Kotagiri. It is recorded that about 1,200 acres of rubber were planted in the Nilgiri District, in small patches or among coffee, at about this time. The largest venture in the Nilgiri District was said to have been by the Glenrock Company at Pandalur, which obtained 16,000 plants from the Burliar Gardens and planted them in the lower part of their estates.

Very brief notes are given below about the three species of rubber mentioned above :—

Para rubber. *Havea brasiliensis:*

This is the source of practically all natural rubber of commerce. Propagation is either by seed or budding. Spacing between trees varies from about 15 by 10 feet to 20 by 20 feet. Tapping is commenced about 4 years after planting when the tree girth reaches about 18 to 20 inches. This stage may however be delayed in less favourable climatic conditions upto 7 years. The plants require a tropical

climate with an annual rainfall of at least about 75 inches. The tapper makes an incision in the bark of the trunk with a suitably shaped tapping knife. The tapping cut should open the latex vessels without injuring the cambium. Usually, tapping is done over half the girth of the tree at one time, in one of several patterns, spiral cut from upper left to lower right or V shaped cut etc. It is best to tap latex on alternate days. The latex is collected in tins, as it drips from the incisions. After collection, the latex is coagulated in shallow pans with dilute acetic acid or formic acid for 24 hours. At the end of this period it forms sheets of crude rubber. This is rolled by machine and washed. The flat sheets are air-dried and then further dried by smoking in "smoke chambers". It is in the form of '*plantation smoked sheet*' that rubber is generally shipped in boxes or in bales of 224 lb. each for export. "Crepe" rubber can also be prepared on plantations. The main process carried out by industrial concerns manufacturing everyday rubber articles is *vulcanisation* which consists mainly of heating the raw rubber with sulphur.

Ceara rubber. *Manihot glaziovii.*

This was of some importance in the earlier days of the rubber industry in the world and was suitable for the drier parts of the tropics, but ever since Para rubber began to hold the field, this was relegated to the background. Spacing of trees is about 12 ft. by 12 ft. Tapping cuts, latex collections and rubber manufacture are on more or less similar lines mentioned above. The tree may be propagated by seed or cuttings.

Panama rubber. *Castilloa elastica.*

Its history and progress as an industrial plant is similar to that of Ceara rubber. In plantations, the spacing adopted is about 20 ft. by 20 ft. Tapping is done very crudely by a cutlass. Latex is allowed to coagulate on the cuts and is collected some days later. It is propagated by seeds.

FIBRE PLANTS

Silk cotton. Kapok. *Eriodendron anfractuosum. (Ceiba pentandra)*

These trees are seen here and there in the lower elevations of the Nilgiris and can thrive from sea level upto about 2,500 feet. It is an upright tree, moderate or large in size, whose pods contain seeds covered with creamy white floss or fibre. Kapok fibre has been widely used for stuffing mattresses, pillows and cushions, etc. Because of its lightness, it is also used for filling lifebuoys and life jackets.

Bombax Malabaricum, D.C. which also yields a silky floss similar to kapok and is called as kapok in India, are also found in the lower elevations of the Nilgiris.

Rhea, Ramie or China grass. *Boehmeria nivea*, Gaud.

This is a perennial shrub, about 6 feet high, native to parts of tropical and subtropical Asia, and cultivated in China, Japan and Formosa. The inner bark yields the Ramie or Rhea-fibre of commerce, which is pure white, strong and of a silky lustre. It is among the strongest and most durable fibres. It is used in making linen substitutes and in the manufacture of gas mantles. Commercial supplies are mainly from China.

The trees thrive in fertile soils upto about 3,000 feet and require a warm moist climate. They are propagated by root divisions or by stem cuttings, preferably the former. The plants are spaced 2 by 3 feet, and can stand in the plantation for about 6 or 7 years. Two to five cuttings are made per annum. In China, the fibre is prepared from these stems by hand, going through the processes of stripping, retting, scraping and drying.

On the Nilgiris, the Indian Glenrock Company made a large scale experiment with ramie, on nearly 600 acres, 400 of which were near Pandalur. It is reported that the plants grew very satisfactorily, giving long, fine stems. But the chief difficulty was evolving an economical method of extracting clean fibre from the stems, and the company was not able to solve this difficulty and abandoned the experiment. It is this problem which has prevented the extension of this plant beyond China and neighbourhood. Nevertheless, it is such a valuable fibre, and the plants are said to thrive on the Nilgiris so well that with the help of more modern and mechanical techniques of extraction, the future possibilities of this useful plant in this hill district require to be thoroughly explored.

New Zealand Flax. *Phormium tenax*, Forst.

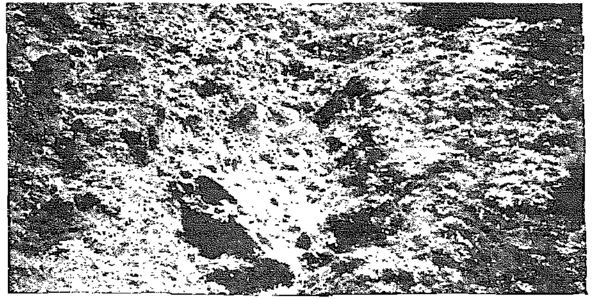
The leaves of this iris like plant yield the fibre called the New Zealand hemp. The plant is a native to the swamp regions of New Zealand. It grows well in cool tropics and temperate regions. It is an important hard fibre plant, yielding fibre of high luster, and is softer and more flexible than *abaca*. The fibre is used mainly for matting, tow lines, and other forms of cordage and to some extent cloth. Good specimens of this plant are seen in the Government Botanic Gardens, Ootacamund, where they stand as ornamental plants. But the author got prepared some good samples of fibre from these plants and the species deserves further investigation on the Nilgiris as an economic plant.

DYES

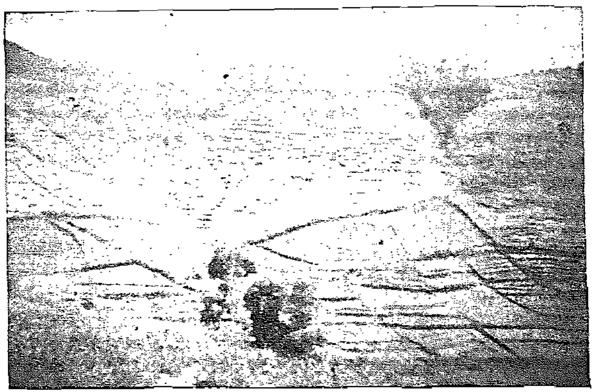
Annatto. *Bixa Orellana*, Linn.

This is an evergreen bush or small tree native to tropical America, and cultivated in many other tropical countries. The ends of branches carry long clusters of pods containing 30 to 50 seeds, surrounded by a scarlet aril which yields a bright yellow dye, called the *annatto* dye. The dye is tasteless and is used for colouring butter, cheese and other food-stuffs. It is also used for wool and calico goods, paints, varnish, lacquer and soap. It is said that some tribes of the Red Indians in America paint their bodies with this dye.

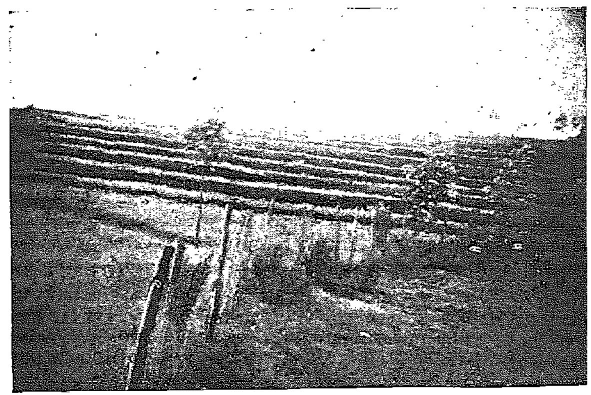
The Kallar Fruit Station on the Nilgiris has very good specimens of this tree. The tree thrives from sea level upto about 2,000 feet in a moist climate. It is propagated by seed. Sown in the nursery, the seedlings can be planted out after about 4 months, giving a spacing of 12 to 15 feet each way. From about the third year of planting, seeds can be obtained. The seeds are either pressed into *annatto paste* or sun dried with their covering and marketed as *annatto seed*. About 5 cwt. of seeds can be expected from an acre of annatto on the average per year.



Top soil completely eroded.



Cultivation on steep lands.



Bench terracing for erosion control.

21. SOIL EROSION IN THE NILGIRIS

by B. M. LAKSHMIPATHY,
B. E., M. E., M. R. A. S. E.,
Joint Director of Agriculture,
Madras and
S. NARAYANASWAMY,
Assistant Agricultural Engineer,
Ootacamund

INTRODUCTION

The Plateau of Nilgiris is spotted with innumerable hills and hillocks which render the country very rolling in nature. Between every two hillocks, invariably a natural stream exists, and all the streams ultimately drain either towards the river Moyar in the North or towards the river Bhavani in the South. These two major river sources which almost surround the Nilgiri Plateau ultimately meet and confluence with the river Cauvery. The rolling nature of the topography, the unprotected steep slopes and ill-managed cultivated lands in the Nilgiris, and the heavy rainfall received in the region conspire together resulting in extensive soil erosion in the tract. The attractive price of potato has of late created a rush for ruthless deforestation of large areas on hill slopes for cultivation of potato, a clean-tilled row crop, irrespective of the steepness of the slope or other adverse conditions accelerating soil erosion. It is estimated that the normal area under potato cultivation on the Nilgiris is 20,000 acres, against an area of only 186 acres in the year 1847. There was a marked increase in potato cultivation after the World War in 1914 and the estimated extent under potato during 1938 was 12,000 acres. The increase was very rapid after 1940 and the area rose to the present extent of 20,000 acres during the past single decade. The total cultivated area of the district is 99,649 acres of which, nearly 20 per cent is under potato cultivation, clearly indicating the importance of potato cultivation in the district. From statistics available, it is also seen that the total cultivated area which was 69,437 acres during 1912 – 1913 rose upto 84,476 acres during 1930 – '31 and to 99,649 acres during 1949 – '50. These facts indicate the rush for bringing in more area under cultivation during the recent past and the resulting denudation of the forest and natural vegetative cover on the area. The cultivated slopes thus devoid of forest and vegetative cover receive the otherwise friendly rain as a foe which strips off the fertile humus-laden and productive top soil resulting in the progressive loss of tons of precious soil. In fact, most of the cultivated lands in the Nilgiris have already lost a large portion of the top soil, and cultivation is maintained increasingly by the profuse application of chemical fertilisers. The fact that the soil layer and its fertility are progressively deteriorating is evidenced also by the requirement of larger and larger quantities of chemical manures year after year for maintaining the yield at the same level in these areas.

The soil erosion in the Nilgiris has attained dangerous proportions and requires the timely attention and unified effort of the farmers and the State for combating this "national menace". As in the other states and

countries, the Madras State has come forward to notify that the Madras Land Improvement Schemes (Contour Bunding and Contour Trenching) Act, 1949 should be made applicable to the Nilgiris district and the adjoining hill slopes in Coimbatore and Malabar districts. The special soil conservation branch of the Agricultural Department is now undertaking soil conservation survey of the district and suitable schemes for soil conservation are being prepared for execution under the Madras Land Improvement Schemes (Contour Bunding and Contour Trenching) Act, 1949.

THE PROCESS OF SOIL EROSION

Soil erosion is the process by which the soil particles are moved from one place to another by an external force. Erosion may be accelerated by wind or by water.

Though the frequency of winds in the Nilgiris is comparatively less, the wind velocity goes as high as 28 miles per hour and the increased speed is maintained during the months of June, July and August when the first crop of potato is in full growth. Due to the high velocity of the wind, the potato haulms beat against the ground and the soil is disturbed, detached and left loose enabling even a light run-off to carry away large quantities of such disturbed soil. As such, it is of importance to provide suitable wind belts in the Nligiris in areas exposed to heavy winds. Trees of economic value, tall and bush varieties like *blue gum* and *wattle* respectively intermingled and planted across the direction of wind are suggested for the area.

FACTORS IN SOIL EROSION BY WATER

Erosion by water depends upon several factors, the most important of which are (a) rainfall, (b) soil characteristics, (c) topography, and (d) present land use. These factors are discussed below.

Rainfall. The intensity and distribution of rainfall play an important part in soil erosion. The soil loss in the Nilgiris is mainly due to the run-off which is directly proportional to the intensity of rainfall. The average annual rainfall of the district is over 74 inches and hence, the problem confronting this tract is not only conservation of the productive soil, but also disposal of the excess water. From the statistics available, it is seen that during the North-East monsoon, the rainfall is very ill-distributed and soil erosion is the maximum during this period. At this critical period of soil erosion, the lands are unavoidably fallow after the second potato crop, and extensive sheet and rill erosion takes place in these fallow lands. Careful consideration should be given to this aspect of the problem and the anti-erosion measures suggested for the area should include introduction of suitable cover crop which should not only produce the maximum canopy during this critical period of erosion, but also check the velocity of the run-off and the resultant soil erosion.

Soils. The soils of the Nilgiris district are of lateritic and gneissic origin. Generally deficient in plant food, they are highly acidic and contain a large percentage of alumina and iron which do not make phosphate available to the plants. The depth of top soil varies from zero to about 2½ feet only on an average and that of the subsoil from 10 feet to 14 feet. Being of gneissic origin, the soil and subsoil are very porous and

allow percolation of a greater portion of the rainfall and thus reduce the amount of run-off and its abrasive action. But the heavy precipitation falling on the area is capable of creating that amount of run-off which can attain ample abrasive velocity to denude the surface layer of the fertile soil. It is due to this character of the soil that mostly sheet and rill erosion only are extensive in the tract.

Topography. As already explained, the topography of the Nilgiris is very rolling in nature and slopes vary from below 10 per cent to 100 per cent.

Present land use. The agricultural practices, configuration and slope of the area are such that work animals are not generally used for any of the agricultural operations. All agricultural operations are attended to only by manual labour who fork the land as deep as 12 to 15 inches with the help of the four pronged garden fork. Breaking clods, making furrows, weeding and harvesting are all attended to with the help of the two pronged multipurpose implement called "Guddaly". Their conventional and age old method of farming is to form ridges and furrows up and down the slope and plant along the slope. In most of the lands, they either practise no anti-erosion methods at all or practise defective methods of anti-erosion. The ryots generally follow a system of shifting cultivation which may be called 'rotational cultivation'. The rotation generally followed by the ryots is to follow potato crop by cereals and then leave the lands fallow for a year or so. Three crops are grown in rotation generally in the district, taking only one crop of potato in each piece of land per year. The early or irrigated crops of potato which are generally raised on swampy and low lying lands or on lands with facilities for irrigation are sown during January and harvested in May–June. The second crop of potato is planted either in August *(Adi bogam)* or in September–October *(Kadai Bogam).* The main crop is sown in March–April and harvested in August–September. Invariably after each potato crop, a cereal like wheat, barley, ragi or samai is grown and the area is left fallow for a year after these cereals. The cereals following the second crop of potato are generally harvested between August and September except Korali which is harvested only in November. The samai has now taken the place of the indigenous korali the cultivation of which has been almost abandoned. As such, the complete area under cereals after the second crop of potato (nearly 50 per cent of the entire acreage of potato cultivation) is left fallow during the entire North-East monsoon period, when erosion is at the maximum.

Lands very near the proximity of villages are found bench-terraced in bits and there the sign of the struggle of the old generation for the preservation and maintenance of the inherited soil wealth is evident. Though defective, these areas at any rate present a marked improvement over the other unprotected areas.

CLASSIFICATION OF LAND ON THE NILGIRIS WITH REGARD TO SOIL EROSION

The terrain of the Nilgiris is such that it is necessary to adopt a standard type of classification as below.

Class I: Uneroded or slightly eroded lands with good soil conditions and practically level land. No special erosion control measures are

required but only crop rotations to maintain soil fertility and moisture conservation methods are needed for this type.

Class II: Moderately eroded lands with soil and other conditions fair and slope upto 10 percent. The conservation measures suitable for this class include American type channel terraces with suitable grades, vertical drains and other agronomical anti-erosion practices like contour cultivation, contour planting, rotational cultivation or strip cropping.

Class III: Highly eroded with conditions fair, and slope 10 to 16 percent. Contour or graded trenches with drop pits together with agronomical anti-erosion methods suggested under Class II are the measures suitable. Wherever necessary, the upper side of the trenches may be re-inforced by the provision of either *Eupatorium* hedges or strips of tall growing and sod grasses to act as an effective stop-wash.

Class IV: Highly eroded land; conditions fair and slopes ranging from 16 to 33 percent. Bench terracing of suitable widths with suitable grades together with vertical drains to take the run-off, drop pits, agronomical anti-erosion methods will be suitable. The slopes of bench terraces need to be protected by suitable grass cover.

Class V: Very badly eroded land, with soil and other conditions very poor and slopes over 33 percent. Contour or graded trenching with vertical drains and drop pits and afforestation with trees of economic value and / or allowing natural growth of grass. The trenches, outlets and edges should be protected by growing Kikuyu grass *(Pennisetum clandestinum)*.

ANTI-EROSION METHODS SUGGESTED

The soil erosion has attained such dangerous proportions that unless in addition to biological means of control, engineering devices of anti-erosion are not followed, it will not be possible to mitigate the loss which has already occurred and prevent further losses.

In the absence of any other research so far on the problem confronting the Nilgiris, the following measures have been so designed as to be capable of assimilation with the existing agricultural practices without in the least affecting the agricultural economy, and are suggested for adoption.

1. Channel terracing.
2. Bench terracing.
3. Graded trenching and afforestation.
4. Diversion channels.
5. Stream protection.
6. Gully plugging.
7. Grass land.
8. Contour cultivation.
9. Rotational cropping.
10. Manuring.
11. Improved implements.

But it must be stated in this connection that before the most suitable methods for the conditions in Nilgiris can be evolved, there is need for a lot of basic and thorough investigations into all factors of soil erosion in this district, and research is required to experiment with several methods of control of soil erosion so as to evolve the cheapest and at the same time most efficient methods of control.

1. *Channel terracing:* This method consists in providing wide and shallow channels along contours with suitable grades so as to induce and regulate the flow of excess water for draining the same. The excavated earth is heaped on the lower side of the channel and a wide broad

based bund is formed. This type is advantageous in the sense that cultivation can be carried on in the channel portion also.

2. *Bench terracing:* It is suggested that steep slopes between 1 in 4 and 1 in 6 should be bench terraced at vertical intervals of 3 to 3½ feet only. The width of benches is kept to the minimum of 6 feet, as the cultivation is carried out only by manual labour. A slight gradient from front to back and gentle grade longitudually are for draining the excess water safely with non-erosive velocity and at the same time allowing scope for absorption of the optimum moisture required for the proper plant growth. A shallow channel at the back edge of the bench terrace is provided for the purpose.

3. *Graded trenching and afforestation:* The principle of providing graded trenches for the very steep area to be afforested is to intercept and divert the run-off safely so that the amount and aggressive power of the run-off water may be reduced to the non-aggressive velocity. A gentle longitudinal gradient is given to these trenches and the excavated earth is heaped on the lower side to form a bund.

Vertical drains and drop pits at suitable intervals are provided to carry the excess water safely down to the valley bottom. The drop pits not only arrest and retard the velocity of water, but also trap what little silt is carried by the flow.

4. *Diversion channel:* The outlets from many of the road culverts are neither protected nor conveyed safely to the valley bottom. As such, waterfall and gully erosions are prevalent below such of these culverts. Suitably protected diversion channels with suitable gradient to convey the out-let water safely down to the valley bottom, are suggested to avert such gully and waterfall erosions.

5. *Stream protection:* Most of the streams running between hillocks of the Nilgiris are narrow and very meandering in nature. If left unprotected, the flowing water attains increased torsion and concentrated strength at every twist and aids stream bank erosion. If left unchecked, the stream may widen, form islands, change their course and attain uncouth meandering courses, thus reducing the adjoining lands and dividing them into unnecessary fragments which would be thrown out of cultivation. It is therefore proposed to smoothen the course of the stream wherever required and protect the stream from bank erosion by leaving a safe marginal limit on either side for vegetational and tree growth.

6. *Gully plugging:* Wherever gullies exist, they need immediate attention lest they may deepen and widen in due course and reduce the area under cultivation. If left unchecked, they may attain a stage beyond control very quickly. Hence, gully plugging should be planned out very carefully and check dams provided at critical espacement commencing from the ridge.

7. *Grass land:* It is an accepted fact that grass is the best soil binder and cover plant. Under the protection of grass carpet, the land not only resists soil erosion, but restores the lost soil fertility. It is therefore, suggested that almost all lands not put under cultivation should be put under grass. In addition to affording good pasturage, grasses protect the soil against erosion when grown on water outlets and on stream banks.

8. *Contour cultivation:* The farmers should practise all cultural operations such as furrowing, ridging etc., contour-wise instead of along slope.

9. *Rotational cropping:* In the absence of any other experiments, the present practice of rotational cultivation followed by the ryots as already explained, may be improved with the addition of a green manure crop like lupin during the fallow period.

10. *Manuring:* Application of Nanjanad fertiliser mixture with a basal dressing of 5 tons of compost or cattle manure in the case of those who have it, is advocated. Application of cattle manure or compost will increase the infiltration capacity of the soil and add to the stability of the same against erosion.

11. *Improved implements:* As already stated, the ryots of the Nilgiris fork the land as deep as 12 to 15 inches. The deeper the soil is tilled, the more is the scope for soil erosion. In the experiments conducted at the Agricultural Research Station, Nanjanad, it was found that 6 inches is the maximum depth of tilling required for obtaining the best results and greater depths do not have any effect on increasing the yield of potato. It is proposed to conduct experiments on the suitability of 6 to 8 H. P. Walking Tractors hitched with ridge plough or turn wrest plough which would not only plough to the optimum depth and tilth, but fetch increased yield with increased efficiency per man hour.

CONCLUSION

Tons of precious and productive top soil are being progressively lost in every acre of land on the Nilgiris. By adopting the productive and protective sound soil conservation means suggested above, the valuable soil resources which form the very foundation for supporting all plant, human and cattle life, can be preserved and maintained. By adopting sound management of the soil, the yield is expected to be increased by at least 20 per cent. By the balanced allotment of land for the various appropriate uses, the area under forest and pastures is increased and scarcity for fuel and pastures will be tided over. Due to increase in fertility, the need for application of heavier dosage of manure every year will not arise and the manurial bill will be considerably lowered, lowering the cost of production as well.

INDEX

ERRATA

Page	*Line*	*For*	*Read*
75	13	Creat Scot	Great Scot
114	29	Rose Scented, and	Rose Scented, which
120	25	Coonoor	Coonoor thoroughly
125 / 132	14 / 22	grape fruit	grapefruit
140	16	involuocrate	involucrate
140	21	alhaloids	alkaloids
146	16	stimulatant	stimulant
180	12	*Eusalyptus*	*Eucalyptus*
190	1	ilgature	ligature
195	8	Badaga	Badagas
200	29	Padocarpuses	Podocarpuses
206	35	:0	20
208	30	Moretona	Moreton
214	44	failing	falling

For verifications of botanical names and families in the text, the index may be referred to.